MACHINERY

DESIGN — CONSTRUCTION — OPERATION

Volume 40 OCTOBER, 1933 Number 2

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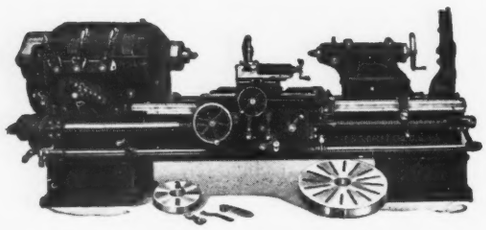

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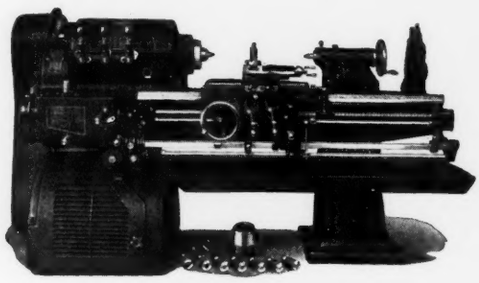

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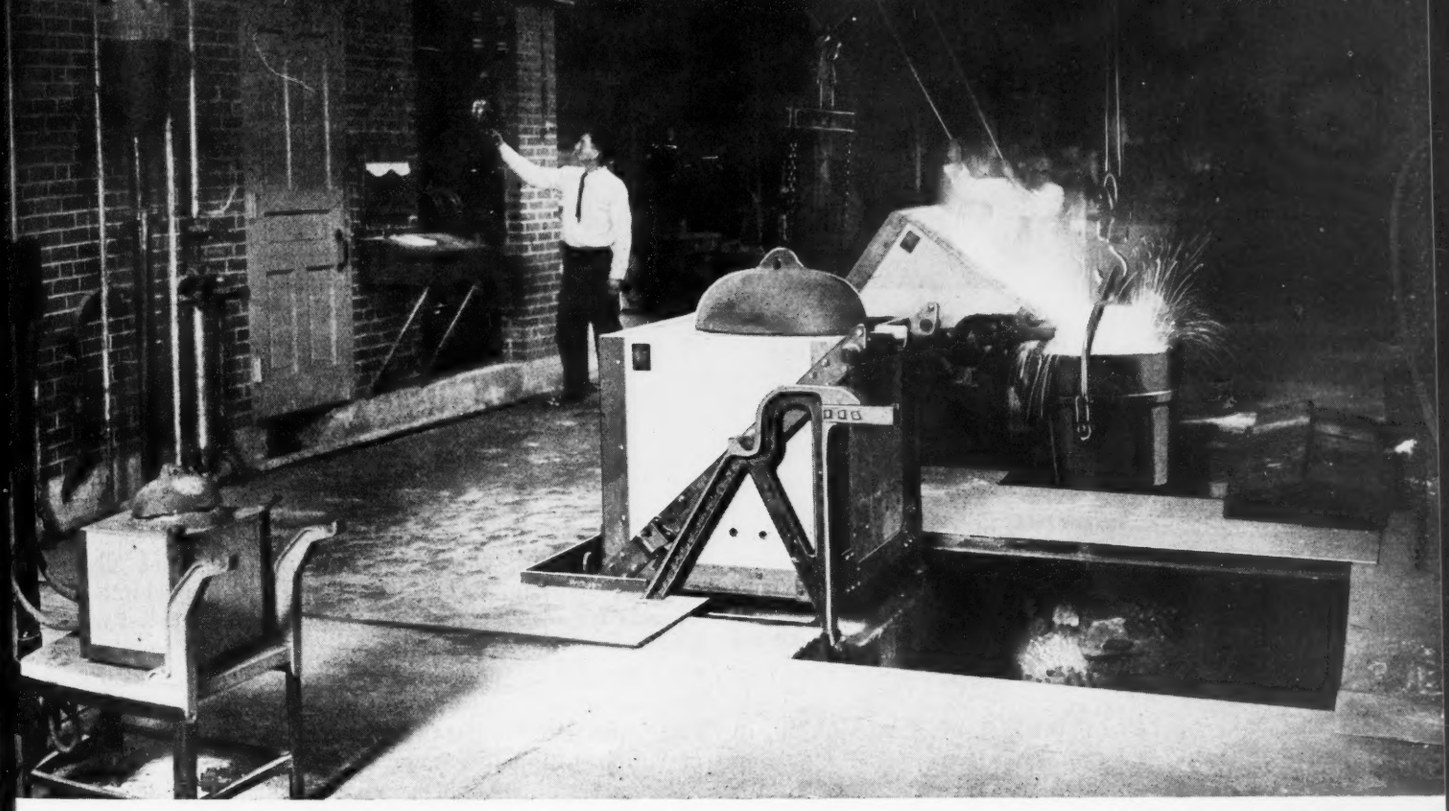


Courtesy Lebanon Steel Foundry

The Age of Materials

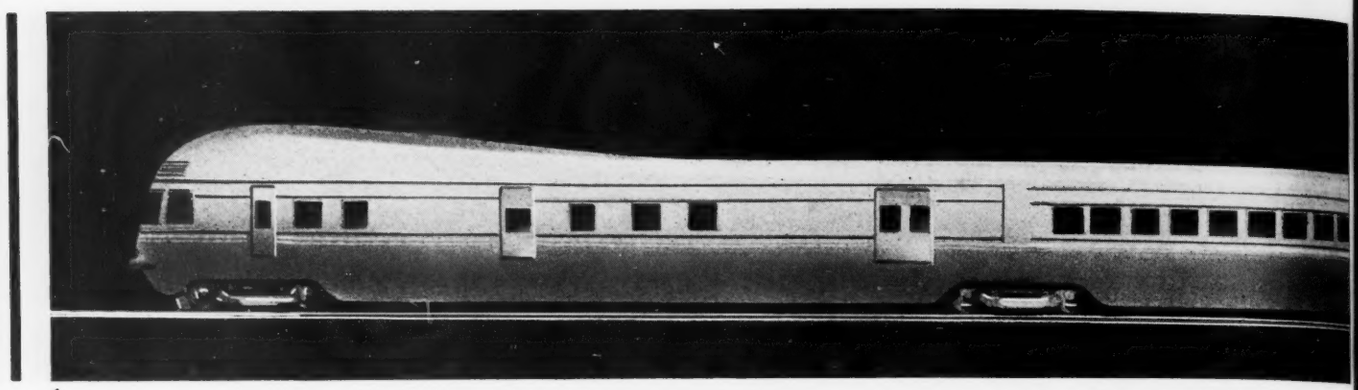
TWO major problems confront every manufacturing executive in his effort to obtain the right quality in his product at the right price—the selection of the material from which it is to be made, and the selection of the methods and equipment by which to make it. Hence, materials—their characteristics and possibilities—are of paramount importance to the manufacturing executive.

This is the age of materials no less than the age of the machine. The tremendous advance that has been made in the development of materials of all kinds within comparatively recent years is but partially appreciated in the engineering field, because few engineers come in contact with more than a limited range of materials.

When we scan the entire field, however, we find that a revolutionary change has taken place. Not only have the old well-known ferrous and non-ferrous materials been improved to an extent that only a few years ago would have been thought impossible, but entirely new materials, unheard of a decade or two ago, have entered the mechanical arena and are now challenging the position of many of the older materials in fields where these were thought to have a monopoly. This is particularly true of the many non-metallic materials that have been developed recently.

If we consider first iron and steel, we find that today castings are made from gray iron with small additions of alloying metals that have a strength, in some cases, equal to that of steel; and by special heat-treatment after casting, practically all the qualities inherent in mild steel may be given to cast parts. The strength and reliability of steel castings, again, has been so vastly increased in recent years that they are now used with perfect assurance for many purposes where formerly only forgings were deemed suitable.

Steel for structural purposes and for forgings has made equally astonishing advances. Through



Aluminum and Alloy Steels are Making Possible the Construction of this Union Pacific Light-weight High-speed Train

the use of small percentages of alloying metals and by means of heat-treatment, the strength of steel can be increased to from three to four times that of the ordinary steels, and at a cost that does not prevent the use of these alloy steels in hundreds of applications for which ordinary grades of steel formerly were used.

Another branch of the art of steel-making in which equally epoch-making advances have been made is that of corrosion-resisting materials. Stainless steel, but a few years ago a novelty, is today used for innumerable purposes, ranging all the way from their application in machine construction to their use for domestic household utensils. Could those who but twenty years ago were seeking a non-corrosive material for practical purposes have known what two decades would bring about in this field, they would hardly have believed the story.

Turning now to the non-ferrous metals, we are again faced by a progress surpassing the boldest dreams of the earlier experimenters. This includes the aluminum and die-cast metal fields, the development of light-weight alloys, and the brass- and bronze-alloy fields, as well as entirely new applications of nickel, copper, tin, and chromium.

Aluminum, for example, forty years ago was almost a rare metal. Twenty years ago its use was still limited, and new applications in the mechanical field caused comment and discussion. Today there is practically no branch of industry where aluminum is not used for some purpose, and there is no home where aluminum utensils are not known. In a comparatively short period of time, its use has extended into almost every phase of civilized life. Much the same can be said of metals used for die-castings other than those containing aluminum.

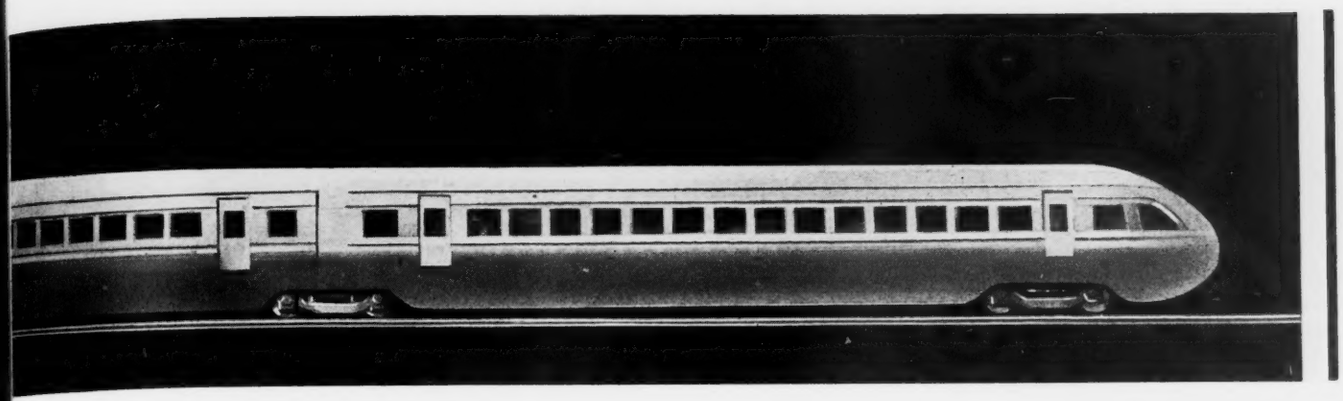
An entirely new series of non-metallic materials has sprung into being. The synthetic-plastic materials have created a place for themselves in industry almost over night. They are of many different types, having varying characteristics, but they are all alike in that they are easily molded and shaped into objects for every conceivable purpose. A curiosity yesterday, they form today one of the most important groups of industrial materials. Closely akin to these plastic materials, and partially in the same class, are the non-metallic materials used for gears, of which millions are now made annually.

Finally, rubber, fiber, and cork have found important applications in machine design and in the mounting of industrial machinery, automobile engines, and delicate instruments.

It is the object of this number of MACHINERY to touch briefly upon the advances made in the development of these various materials and to indicate the successful applications of each. The aim is simply to call the attention of the mechanical executive, the designing engineer, and the production manager to the wide choice of materials now available and to the possibilities of these materials.

A few years ago, the choice of materials for any given purpose was a narrow one. In some cases, there was no choice at all, and the material that had to be used was not always particularly well suited to the purpose for which it was employed; but there was no substitute. Today, several materials can frequently be used for the same purpose. One material may possess certain advantages, while another is preferable for other reasons.

It is important that the engineering executive should know the possibilities of the different types of materials so that he may make an intelligent choice between them and select the one best suited to the particular purpose in view. To the extent to which these articles may aid in bringing about a keener appreciation of the possibilities of different types of available materials, their object will have been achieved.



Materials Main Factor in New Type Railway Train

E. E. Adams, Vice-president of the Union Pacific System, and Designer of New Light-weight, High-speed, Streamline Train

THE most revolutionary change in railroad transportation methods in many decades finds expression in the new high-speed streamline train now being built for the Union Pacific Railroad by the Pullman Car & Mfg. Corporation. In this achievement, newly developed materials play a most important part. In fact, it would have been impossible to construct this light-weight high-speed train except by the use of materials in the car bodies, frames, and trucks that would give greater strength with less weight than was possible with the older materials. Consequently, aluminum alloys have been selected for the car bodies and frames, while alloy steels are used to the fullest extent possible in the construction of the trucks, in order to gain strength and reduce weight.

Stainless steel, again, is used liberally throughout the train for many fittings, advantage being taken of the very latest developments in all the materials of engineering. Even rubber is liberally used in the truck construction.

The result is a three-car all-metal train weighing only 80 tons—equal to the present weight of a single Pullman sleeping car. This train is capable of running at a speed of 110 miles an hour and is designed for a sustained speed on straight level track of 90 miles an hour. There could be no more spectacular illustration of what can be achieved by the use of modern materials.

Throughout the design of the new train attention has been paid to automotive and aircraft developments, where speed and light weight combined with strength have been a vital necessity. Furthermore, the train is streamlined to a greater extent than has ever been attempted in this or any foreign country. Computations indicate that proper streamlining will reduce the power requirements at 100 miles an hour more than one-half, as compared with the ordinary railway train.

To get the full benefits of streamlining, the windows are placed practically flush with the outside of the car; the vestibules between the cars are covered to continue the smooth sides of the cars; and such devices as headlights, tail lights, whistles, bells, etc., are recessed into the car body. A specially designed mechanism opens the doors and lets down folding steps for entering and leaving the car.

Of course, the train will be fully air conditioned. The windows are sealed, and forced ventilation heats the train in the winter, cools it in the summer, and filters all dirt and dust from the outside air.

Furthermore, the sealed windows, the body insulation, the complete streamlining, and the liberal use of rubber in the trucks will materially reduce all noise. That the train is completely equipped with modern roller bearings, in order to reduce friction and avoid the necessity of terminal attention, goes without saying.

The design of the train is the result of an exhaustive study into the development of a light high-speed train that will provide safe and comfortable transportation at a minimum cost, undertaken by E. E. Adams, vice-president in charge of engineering of the Union Pacific System, in collaboration with several well-known companies and engineers in the transportation field. The experience gained with this train when placed in service will prove a guide for future developments.

The Part Played by Alloy Steels in the Machine Age

The Use of Alloy Steels Has Made Possible New Achievements in Machine Design and Construction

ALTHOUGH iron and steel are the most generally used materials in the engineering field, the tremendous improvements that have been made in these materials during recent years are not fully appreciated in the mechanical industries. The possibilities offered by these improved materials in machine construction are so far-reaching that every engineer and designer will find it to his advantage to investigate thoroughly the full significance of these new developments.

Many of the difficulties experienced by designing engineers of an earlier day were due not so much to their lack of appreciation of design principles as to the fact that no materials were available by means of which their ideas could be effectively translated into successful equipment and apparatus.

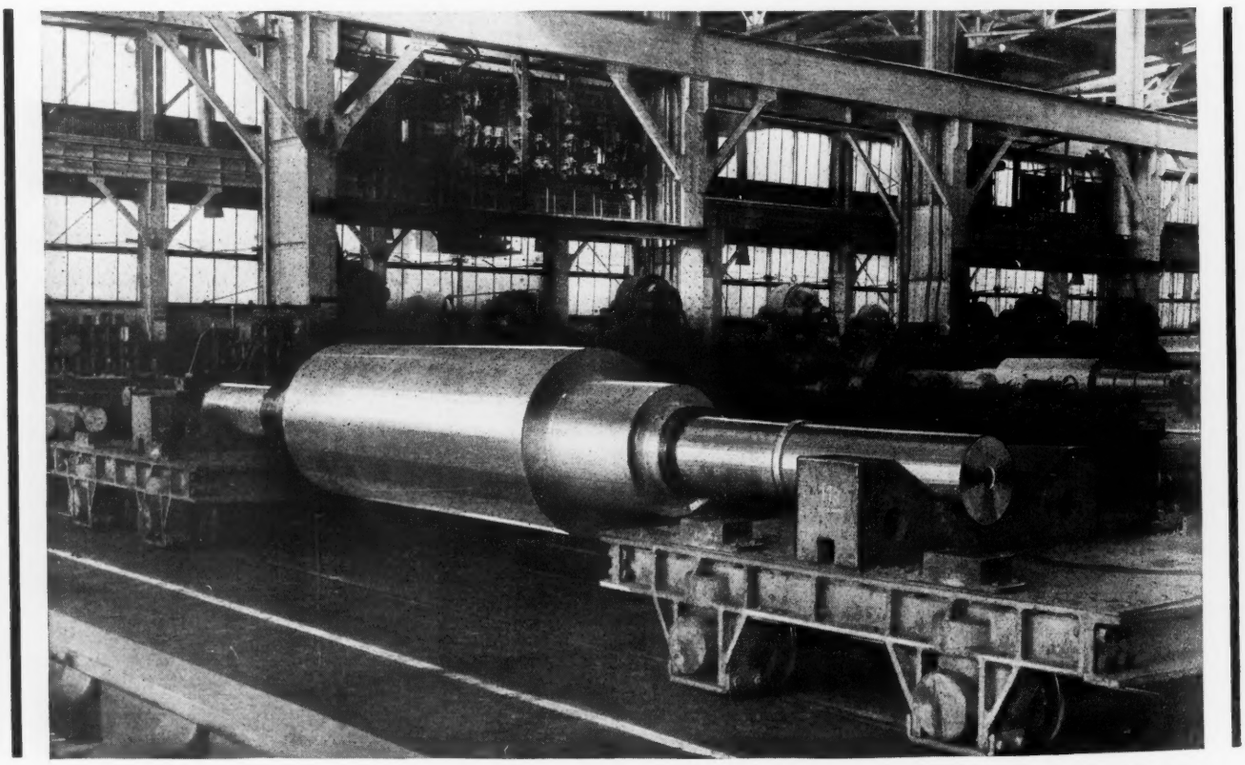
This condition has changed. Today, partly by improvements in the art of handling and treating iron and steel, but mainly by virtue of the alloying metals used, it is possible to produce materials that in strength, endurance, corrosion-resisting qualities, and appearance so far excel the materials of yesterday that the engineers of that day would have thought such improvements well nigh impossible.

It is fairly safe to say that the automotive industry pioneered the development of alloy steels. The automobile required stronger materials for the same weight and the steel industry was asked to produce them.

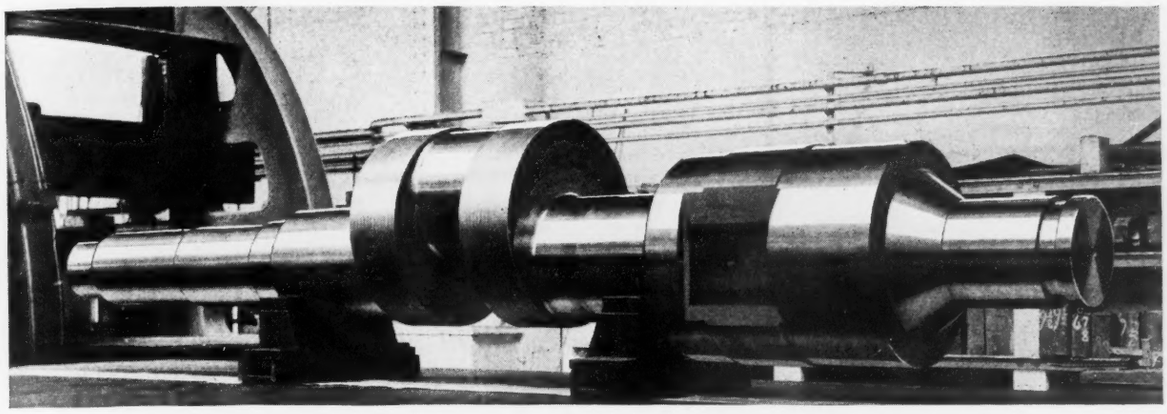
According to the usually accepted definition, an alloy steel is a steel, the properties of which are attributable to some element other than carbon. The alloying elements used are primarily nickel, chromium, vanadium, molybdenum, silicon, and manganese. Sometimes two or more of these elements may be present in the same steel.

Generally, alloy steels require to be heat-treated before they are used, because only by the proper

Three Per Cent Nickel Steel Turbo-generator Shaft Weighing 60 Tons. Length over all 28 1/2 Feet. Largest Diameter 4 1/2 Feet. Forged by the Erie Forge Co. for the General Electric Co.



Courtesy International Nickel Co., Inc.



A Chrome-nickel-molybdenum Steel Crankshaft Weighing 7130 Pounds. Tensile Strength and other Physical Properties Unusually High. Made by A. Finkl & Sons Co., Chicago, Ill.

heat-treatment are the remarkable qualities of these steels developed. Alloy steels that are not heat-treated frequently differ in strength and other physical properties but little from ordinary steels; but with heat-treatment, most remarkable results are obtained.

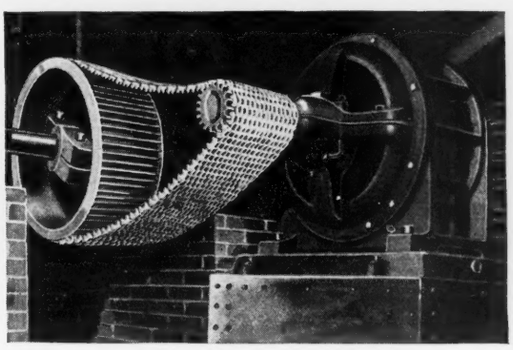
Among the alloy steels, the nickel steels are of prime importance. Nickel-alloy steels containing from 0.5 to 7 per cent nickel are available, containing often, in addition to nickel, small percentages of chromium and molybdenum. These steels are noted for their dependability, high strength, and toughness. They are used extensively in automobile and aircraft construction, rolling-mill equipment, machine tools, and other metal-working machinery, agricultural machinery, and recently, to an ever increasing extent, in locomotive and railway rolling stock construction.

In addition, there are corrosion-resistant steels with a nickel content of from 7 to 35 per cent, and there are also heat-resistant steels with a similar nickel content. High-nickel heat-resistant alloys with from 35 to 85 per cent of nickel are also available, as well as electrical-resistance alloys that are widely used for heater, pyrometer, and rheostat wire. The latter materials, however, are rather in the class of nickel alloys than of alloy steels.

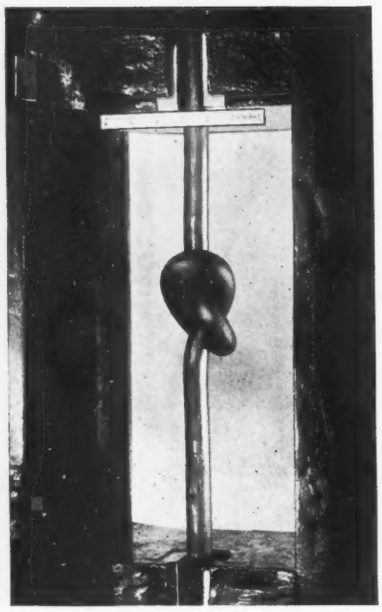
Recently nickel-clad steel plate has made its appearance. This is a composite plate consisting of steel to which a layer of pure nickel has been bonded. This nickel-clad steel plate is used where the corrosion resistance of nickel is required in heavy construction at low cost. Nickel-clad steel plate finds wide application in the food and chemical industries, in laundries and dry-cleaning establishments, and in dyeing and bleaching equipment.

Some specific examples of results obtained by the use of alloy steels are here recorded. After the New York Central locomotive No. 5344, built by the American Locomotive Co. in Schenectady in 1931, had completed 120,000 miles of service, a thorough inspection showed all parts to be in excellent condition, no major repairs and no replacements being required. This remarkable record was due in no small degree to the materials employed. Alloy steels were used liberally throughout the construction, not only of the moving parts, but also of the boiler shell, firebox staybolts, and superheater parts. In addition, the drivers of the engine are equipped with Timken tapered roller bearings in which both the rollers and the races are of nickel-alloy steel.

The Erie Forge Co. of Erie, Pa., recently completed an immense turbine-generator rotor shaft for the General Electric Co. The shipping weight of this shaft was 121,900 pounds, the over-all length 28 1/2 feet, and the maximum outside diam-

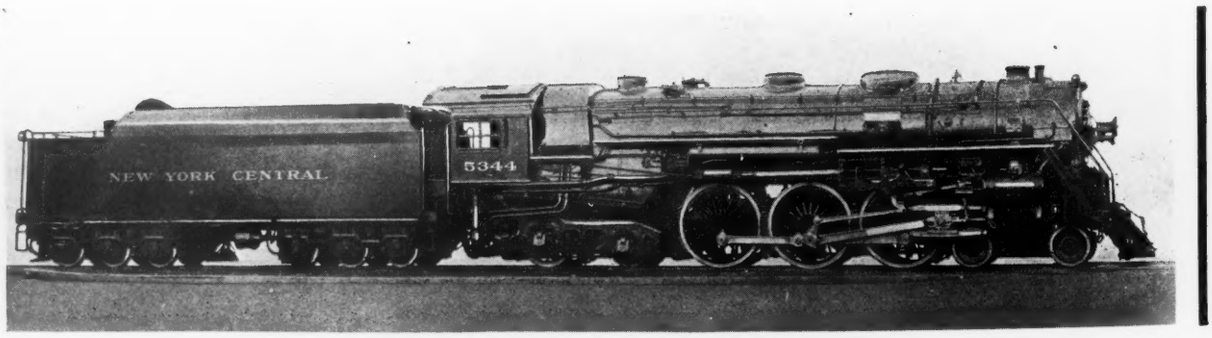


Heavy-duty Link-Belt 150-horsepower Silent Chain Drive with Links, Pins and Bushings Made from Nickel-alloy Steel

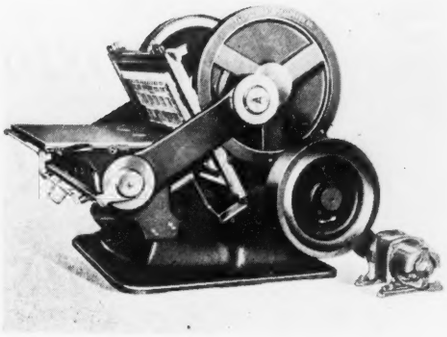


Tying Knots in Cromansil Steel May Not be a Pastime for Sailors, but it Can be Done. This 1-inch Round Staybolt Stock of Cromansil Steel is Tied Cold into a Knot Without Fracture—Courtesy Linde Air Products Co.

An Example of the Quality of Modern Sheet Steel—a Complete Kitchen Sink, Including Drainboards, Made by the Youngstown Pressed Steel Co. from One Piece of the American Sheet & Tin Plate Co.'s Sheet Steel—A Tribute Alike to Steel Maker and Fabricator



Alloy Steels were Used Liberally in the Construction of this Engine, Built by the American Locomotive Co. After 120,000 Miles of Service it Required No Major Repairs



The Use of Chrome-molybdenum Steel in the Connecting-rods of the Thomson-National Press Co.'s Presses has Permitted Smaller Sections and Lighter Rods

eter 53 1/2 inches. Because of the high strength required, a 3 per cent nickel steel was used.

Alloy steels meet requirements of this kind especially well, because most machinery and equipment in which steel comprises an essential material of construction are subjected to over-stressing, at least occasionally. For this reason, materials must be selected not solely on the basis of their ultimate strength, but for their ductility and toughness—their ability to withstand an occasional load beyond that to which the machinery is ordinarily subjected. Alloy steels can be produced having higher yield points and tensile strengths without sacrifice of ductility; and by adjusting the carbon content, improved ductility can be obtained without sacrifice of strength.

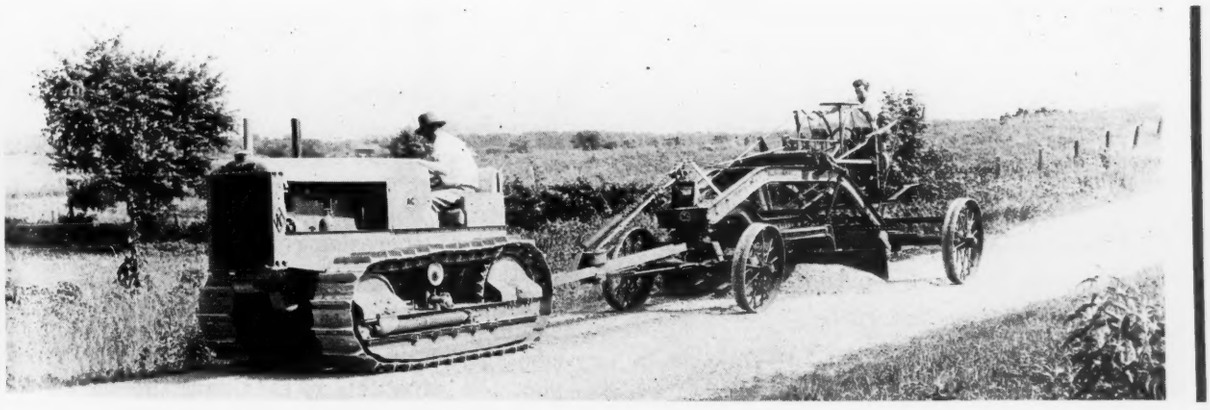
Nineteen years ago, the Link-Belt Co., of Chicago, installed a 150-horsepower silent chain drive for transmitting power to a lineshaft in the plant of the Ohio Clay Co., Cleveland, Ohio. This drive is still rendering satisfactory service, using the original sprockets. The chain has been repinned and rebushed only once since 1914.

Again, materials are a vital factor in attaining such service records. The Link-Belt Co. attributes the long life of the chain and sprockets not only to its construction, but also to the fact that the links, pins, and bushings are all made from nickel-alloy steels.

It is evident that, in building structures where so exacting a service is required as in airplanes, a most liberal use should be made of alloy steels. In the Boeing airplanes, alloy-steel bar stock is used that has a tensile strength of 125,000 pounds per square inch with a yield point of 100,000 pounds per square inch and a reduction in area of 50 per cent. Alloy-steel tubing is used having a tensile strength of 95,000 pounds per square inch and a yield point of 75,000 pounds per square inch. Alloy-steel sheets are also employed with a tensile strength of 90,000 pounds per square inch and a yield point of 70,000 pounds per square inch.

The Allis-Chalmers Mfg. Co. has developed a tractor in which all the important parts are made from alloy steel and which includes the innovation of pneumatic tires. The rear axle shafts, differential gears, pinions and spider, and transmission gears are all of alloy steel, mainly the 3 1/2 and 5 per cent nickel carburizing types. The success of these tractors during severe tests points to a still greater future for alloy steels in farm equipment, since the higher stresses imposed by the increased speeds of modern equipment necessitate the use of superior materials. Another new tractor in which alloy steels are liberally used is illustrated below.

In the preparation of this article, much information has been obtained through the courtesy of the International Nickel Co.



New Allis-Chalmers Tractor that Gives Remarkable Performance Because of Advanced Design Features and the Liberal Use of Alloy Steels in its Construction

A Variety of Automobile Parts, Fittings, and Appliances for Various Uses, Made from the American Sheet & Tin Plate Co.'s Corrosion-resistant Steels, Showing the Wide Application of These Materials

Corrosion-Resistant Steel—The Metal of a Thousand Uses

THE production of alloy steels having corrosion-resistant properties approaching those of gold and platinum is an achievement destined to have a far-reaching effect on our industrial development. The two alloying metals that have made possible the different groups and kinds of corrosion-resistant steels now available are chromium and nickel. Comparatively small quantities of other elements, as indicated in the accompanying tables, are added in some cases to obtain certain properties.

Between the hardenable, straight chromium alloys used for cutlery and the tough chromium and nickel alloys that retain their strength and ductility at temperatures up to 2000 degrees F. is a range of corrosion-resistant alloys having physical properties that cover a broad field of application. The wide range of these applications is referred to by Walter M. Mitchell, metallurgical engineer of the U. S. Steel Corporation, in a paper recently presented, as follows:

" 'Stainless steel' has been called the 'metal of a thousand uses,' and while this may be somewhat of an exaggeration for the original hardenable analyses of Brearley and Haynes, it by no means exaggerates the possible applications of the group of corrosion-resistant alloys known today under the general name of 'stainless steels.'

"The importance and influence of these alloys are manifest in the widest and most diversified activities—from hypodermic needles to the ponderous reaction chambers of the oil refinery; from containers to resist the mild corrosion of milk and dairy products to tanks for the strong acids of chemical industries; from watches and novelties in jewelry to decorations for the mightiest skyscrapers in the world; from the delicate construction of parts for airplanes and dirigibles to bank vaults and strong boxes. In all of these, and many more, the use of corrosion-resistant alloys has been advantageous in one way or another.

"The large number of corrosion-resistant alloys available at present and the slight differences in composition of some of them undoubtedly must perplex the prospective user, and he may be sympathized with if he finds himself unable to picture the differences between them or to decide which will be most suitable for his particular purpose.

"Diversified as the applications of stainless alloys have been, they have, nevertheless, a definite logical

The Advent of the Group of Corrosion-Resistant Steels Known as Stainless has Completely Revolutionized the Choice of Materials and Production Methods in the Fabrication of Thousands of Machinery Parts and Articles in Common Use

field of usefulness, and they cannot arbitrarily be substituted with profit for the cheaper grades of steel. Their commercial utility will therefore be based on the existence of certain demands or requirements, which experience has shown cannot be satisfied by the use of already known metals or alloys; and on those applications where the advantages gained will justify their greater cost.

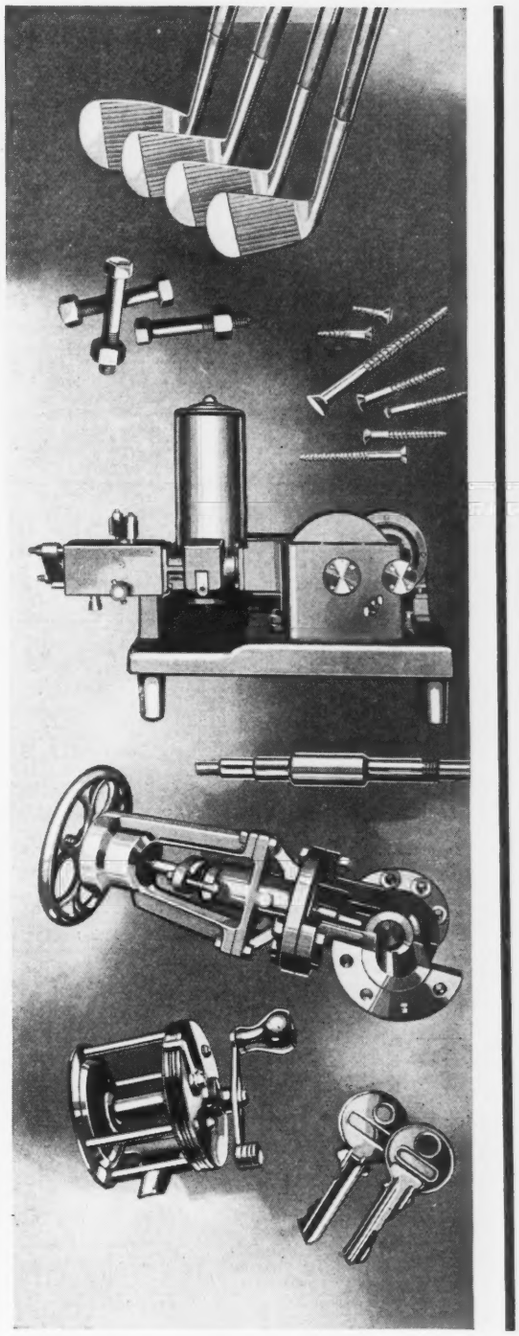
"These requirements may broadly be divided into two groups which are, of course, not necessarily independent, as follows:

"1. *Requirements for Corrosion Resistance*—This includes resistance to high temperature oxidation, for this is merely a form of corrosion. Under this should also be included requirements for decorative materials, since the ability to maintain an untarnished surface is merely the evidence of unusually complete resistance to corrosive attack.

"2. *Requirements for Unusual Mechanical Properties of Hardness, Strength, Toughness, or Ductility*—With this should be included requirements for resistance to wear and abrasion."

The many different terms and trade names applied to corrosion-resistant steels are somewhat confusing. "Stainless steel," as referred to by Mr. Mitchell in the preceding outline, for example, is a term commonly used to indicate any or all rustless steels or iron alloys designed to resist atmospheric corrosion, the attack of hot or cold acids, and scaling at elevated temperatures. However, "Stainless Steel" is strictly a trade name, originally applied to cutlery steels containing no more than 0.70 per cent carbon and from 9 to 16 per cent chromium, which were patented in 1916 by the English metallurgist Brearley, and the genuine "Stainless Steel" produced in this country is a straight chrome-iron alloy made under patents owned by the American Stainless Steel Co., Pittsburgh, Pa.

A few examples of the many diversified applications of corrosion-resistant steels will doubtless prove a revelation to those who have not kept in close touch with developments in this field. One application recently noted is that of a truck body floor beam 5 or 6 feet in length which weighs only 10 pounds but which has a service load capacity of 10 tons. The thin channels of corrosion-resistant steel used in fabricating this beam are assembled by shot welding. While a beam of the same weight and load-carrying capacity might be made from



The Range of Stainless Steel Extends from Machinery Parts to Golf Clubs. Its Many Uses are Well Exemplified in This Illustration of Products Made from the Carpenter Steel Co.'s Stainless Steel

Table 1. Types and Applications of Corrosion-Resistant Steels

Firth-Sterling Steel Company, McKeesport, Pa.

Type		Elements Identifying Typical Compositions, Percentages					General Applications
		Carbon	Silicon	Manganese	Chromium	Other Elements	
Hard Types (Semi-Martensitic and Martensitic)	Turbine Type	0.12	0.20	0.40	12.50	Nickel, 0.40	High tensile strength machinery type. Turbine blades, valve parts, pump rods, pistons, cutlery and tableware.
	Original Cutlery Type	0.35	0.20	0.35	13.50	.....	Table knives, scissors, spatulas, cleavers, hatchets, pump shafts, pistons, and valve trim.
	Modified Cutlery Type	0.70	0.40	0.45	16.50	.....	Butcher knives, pocket knives, dental and surgical instruments.
	Ball Bearing Type	1.05	0.45	0.40	17.00	.....	All purposes where maximum resistance to abrasion is required in a corrosion-resistant steel. Balls, races, valve seats, all bearing surfaces.
	Poppet Valve Type No. 1	0.50	2.75	0.50	8.75	Vanadium, 0.15	Internal combustion engine valves.
	Poppet Valve Type No. 2	0.45	0.90	0.40	10.00	Aluminum, 1.80	Especially exhaust valves for automobiles and airplanes.
Soft Types (Semi-Ferritic and Ferritic)	18 Per Cent Chromium Iron	0.10	0.50	0.50	18.00	Nickel, 0.30 max.	A soft ductile material that does not work-harden readily; not as resistant as "18-8," but useful for interior work.
	28 Per Cent Chromium Iron	0.15	0.50	0.50	28.00	Nickel, 0.30 max.	For all applications where strength and toughness are secondary to high-temperature resistance. Furnace parts, glass molds, etc.

Table 2. Free-Cutting Types of Corrosion-Resistant Steels

Firth-Sterling Steel Company, McKeesport, Pa.

Type	Elements Identifying Typical Compositions, Percentages									
	Carbon	Silicon	Manganese	Sulphur	Phosphorus	Chromium	Molybdenum	Nickel	Zirconium Sulphide	Selenium
Type No. 1, Molybdenum Sulphide...	0.10	0.25	0.45	0.25	0.025	14.00	0.40	0.25	None	None
Type No. 2, Zirconium Sulphide.....	0.10	0.25	0.45	.....	0.025	14.00	None	0.25	0.40	None
Type No. 3, Selenium Straight Chromium.....	0.10	0.25	0.45	0.025	0.025	14.00	None	1.00	None	0.25
Type No. 4, Selenium "18-8".....	0.10	0.50	0.90	0.025	0.060	18.00	None	8.00	None	0.25

The above compositions are applied where free-cutting properties are required in a heat- and corrosion-resistant steel. The desirable crisp, free-machining effect is obtained through the addition of sulphur or selenium. These elements not only impart the desired machineability, but also make the finish-machined surface of the work smooth and of a self-lubricating, non-galling nature.

Table 3. Types and Applications of Corrosion-Resistant Steels

American Stainless Steel Co., Pittsburgh, Pa.

Type of Stainless Steel	Range of Chromium and Carbon Content Identifying Types of Stainless Steel		General Applications
	Chromium, Per Cent	Carbon, Per Cent	
Type A	9.00 to 16.00	Over 0.12	Type A material is used in high-grade cutlery and for all other purposes requiring a hard heat-treated material, such as balls and seats for valves, surgical and dental instruments, etc.
Type B	Over 16.00	Over 0.12	Type B material is used in high-grade cutlery, particularly pocket knives, and in other hard heat-treated products. As the chromium increases, the carbon must also be increased to give hardness. Whereas in Type A the normal carbon range is 0.25 to 0.35 per cent, Type B will sometimes run as high as 1 per cent in carbon, depending upon the chromium content.
Type C1	15.00 and under	0.12 and under	Type C1 is probably used in larger tonnages than any other type. It does not require heat-treatment and is applied to such products as chemical, dairy, laundry, and oil equipment. It has wide applications, since it provides a soft corrosion-resistant material at a fairly reasonable price.
Type C2	15.00 to 18.00, inclusive	0.12 and under	Type C2 is growing in popularity because its high chromium content gives it corrosion-resisting properties somewhat superior to those of Type C1, and therefore fits it for use in outdoor construction in such products as automobiles, architectural trim, etc. This type of stainless steel is being used in constantly increasing quantities for all kinds of highly polished parts for automobiles. Architects and builders are using it for bank vault construction, finish for safe deposit box doors, stair railings, elevator grills, etc.
Type C3	18.00 to 23.00, inclusive	0.12 and under	Types C3 and C4 are only used where the most extreme corrosive conditions exist.
Type C4	23.00 to 30.00, inclusive	0.12 and under	

Table 4. Types and Applications of Corrosion-Resistant Steels

The Carpenter Steel Company, Reading, Pa.

Brand Name	Elements Identifying Typical Compositions, Percentages				Recommended Uses
	Carbon	Chromium	Nickel	Other Elements	
Carpenter Stainless No. 1	0.10	12.00 to 14.00	....	....	Cold-rolled strip used extensively for all sorts of stampings, moldings, etc. Bars, wire, etc., for valve trim, turbine blades, pump shafts, bolts, nuts, nails, and many heat-treated parts.
Carpenter Stainless No. N-1	0.10	13.00	2.00	....	Supplied principally in hard cold-rolled strip—used for mild springs, cutlery, spatulas, rules, tapes, etc.
Carpenter Stainless No. 2	0.30	13.00	....	....	Used only in fully hardened condition for cutlery, scissors, surgical instruments, rules, tapes, ball bearings, dental instruments, ball check valves, etc.
Carpenter Stainless No. 2-B	0.95	17.00	....	....	Used for same purposes as Carpenter Stainless No. 2. No. 2-B gets somewhat harder, but is more difficult to handle.
Carpenter Stainless No. 3	0.30	20.00	....	Copper 1.00	No. 3 does not become embrittled by grain growth at high temperatures—used largely for scale-resisting purposes.
Carpenter Stainless No. 4	0.10	18.00	9.00	....	Used extensively in cold-rolled strip for stampings, moldings, etc. In form of wire for woven screen, etc. Machined parts should be made from Carpenter Stainless No. 8.
Carpenter Stainless No. 5	0.10	14.00	....	Sulphur 0.30	A free-machining grade for parts made on automatic screw machines or machined from forgings—valve trim, pump shafts, bolts and nuts, golf club heads, etc.
Carpenter Stainless No. 6	0.10	17.00	....	....	Used almost exclusively in form of cold-rolled strip for making stampings, moldings, etc.
Carpenter Stainless No. 8	0.10	18.00	9.00	Selenium 0.25	A free-machining grade for use in automatic screw machines or forgings to be machined. Recommended for parts requiring greater corrosion-resistance than Carpenter Stainless No. 5.

Table 5. Types and Applications of Corrosion-Resistant Steels

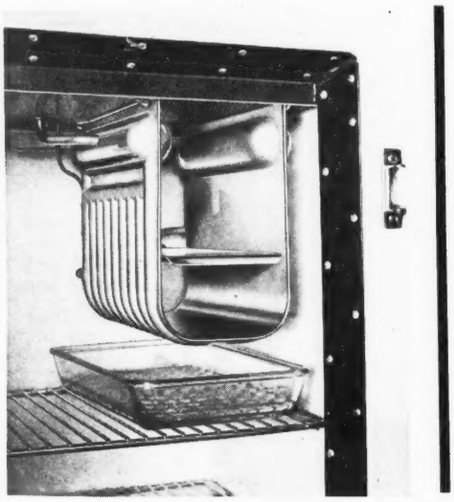
Firth-Sterling Steel Company, McKeesport, Pa.

High Corrosion-Resistant Chromium-Nickel Alloy Types (Austenitic)

Elements Identifying Typical Compositions, Percentages						General Applications
Carbon, Max.	Silicon	Manganese	Chromium	Nickel	Other Elements	
0.15	0.25	0.35	15.00	11.00	.....	Culinary utensils, flat tableware, jewelry, dental and surgical instruments not requiring a sharp edge.
0.15	0.60	0.40	18.00	8.00	*(See Modified Forms)	Adapts itself to tubing and sheet material. Finds useful application in the oil industry.
0.07	0.60	0.40	18.00	8.00	.....	Very malleable for both hot and cold working. High resistance to all forms of corrosion. A general-purpose soft material.
0.20	2.50	0.60	18.00	25.00	.....	Retains its strength and toughness at temperatures up to 2000 deg. F. Highly resistant to heat oxidation and chemical corrosion.
0.20	0.50	0.60	24.00	12.00	.....	Oil-burner parts, oil-refining equipment, chemical plant equipment. Retains its strength and toughness at high temperatures.
0.15	1.00	0.60	25.00	20.00	.....	A highly efficient heat-resistant steel. Used for furnace doors, skids, retorts, tubes, heat exchangers, pump and valve parts.
0.35	1.25	0.75	8.00	21.00	Copper 1.25	Adapted to salt water and sulphuric acid resistance for ship parts, periscope tubes, pump shafts and valve trim in the oil industry.

*Modified forms of Nirosta "18-8" steel for special purposes are obtained as indicated below.

Elements Added to "18-8" Steel	Percentages of Elements Added	Purposes for which Elements are Added
Tungsten	2.00–4.00	Offers greater resistance to sea water.
Copper	2.00–4.00	Increases resistance to ammonium chloride.
Titanium	0.80	Improves resistance to inter-crystalline corrosion. Produces better non-warping properties in sheets.
Molybdenum	2.50–3.50	Furnishes better resistance to sulphurous acid.
Silicon	2.00–2.50	Improves resistance to scaling at high temperatures.
Selenium	0.25	Imparts free-machining properties without sacrificing strength and toughness.



General Electric Refrigerator Freezing Chamber Drawn from Allegheny Steel Co.'s 18-8 Stainless Steel—an Outstanding Sheet-metal Drawing Job

ordinary steel, it would be impractical, because the thin sections might be weakened by corrosion.

Pipe and pump fittings of cast stainless steel having 18 per cent chromium, 8 per cent nickel, and approximately 0.15 per cent carbon represent another recent application. A dough mixing tray made from several separate pieces welded together has the appearance of being one solid piece. This illustrates the progress being made in the fabrication of these materials by welding.

Surgical instruments, operating tables, sterilizers, stands, stools, and other equipment for hospitals are now made from this metal. Another application in which steel is now successfully replacing gold is dental plates, crowns, and inlays. Plates made from stainless steel are said to be preferable to those made from gold or rubber. They can be made much thinner than gold plates, and consequently are much lighter. Also, the cost is one-fourth that of gold.

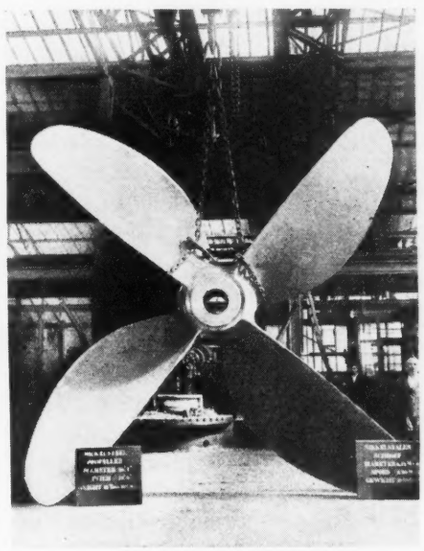
Automobile hub caps, knobs, and many other automobile parts now produced in large quantities make this steel of great importance in the automotive field. Other examples of applications in which corrosion-resistant steels are being used successfully under severe corrosive conditions are steam turbine parts and oil burner shells.

A New Industry Demands a New Material—Welded Stainless-steel Beer Barrels Have Created an Additional Demand for the Product of the Steel Maker

Courtesy Linde Air Products Co.

Using Steel Castings for Strength and Reliability

The New Requirements for Strength and Endurance Imposed on Machine Parts are Fulfilled by Modern Alloy Steel Castings



Courtesy International Nickel Co., Inc.

Huge Nickel-steel Propeller Weighing 27,500 Pounds, Made by the Netherlands Steel Co. for a Norwegian Whaling Boat

IMPROVEMENTS in the art of casting steel have been extremely rapid during recent years. Metallurgical control of melting and pouring, new alloys for special uses, advanced heat-treating methods, and other innovations have increased the field of application of this important material of engineering. Many machinery builders have taken advantage of these improvements in the steel foundry art by redesigning frames and other machinery parts for the use of steel castings. Heavy bulky castings have been redesigned to form much lighter construction. Parts subject to corrosion and erosion can also be cast from steel of special composition.

Many of the alloy cast steels, contrary to what is frequently believed, are easily machineable. Another important consideration is the fact that steel castings can be welded—either fitted integrally into a composite steel structure or joined to one another.

It is not generally appreciated that in using steel castings it is not always necessary to employ the high-alloy steels in order to obtain quite remarkable physical properties. Ordinary carbon-steel castings are available that will give a high range of tensile strength, yield point, and ductility. The selection of the carbon content, special heat-treatments, and in some cases moderate additions of alloy metals will produce these results. Of particular importance is the property of high ductility found in most cast steels. This material will stretch and distort a great deal before it breaks, even under severe overload conditions. It is, therefore, not so liable to sudden failure as some of the materials that it replaces.

In a paper read before the American Foundrymen's Association, Albert G. Zima of the International Nickel Co., divides alloy-steel castings into six groups, as follows:

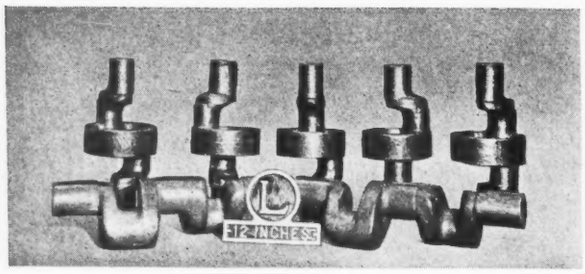
1. High-ductile steels which are resistant to shock and fatigue at atmospheric and low temperatures. These are low-carbon nickel steels used for locomotive frames and castings for mining, excavating, and steel-mill machinery, as well as ship castings. Similar steels with a higher carbon content are used for various locomotive castings; large gears not subjected to severe abrasion; and crusher, tractor, and power-shovel frames.

2. Nickel-manganese steels of moderate cost with strength and ductility superior to ordinary steel castings. These are used when the properties required do not warrant the use of higher-priced alloy steels. They are used for many castings in tractors, motor trucks, and road-building machinery, and have been employed successfully for electrical machinery castings with sections up to 6 inches in thickness.

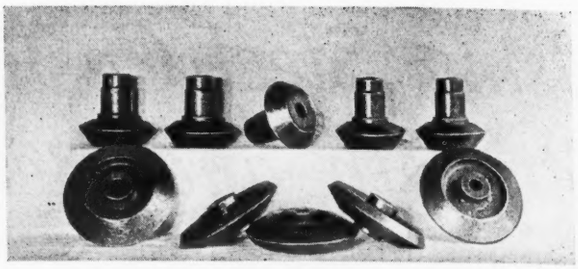
3. Nickel-chromium and nickel-molybdenum steels with superior mechanical properties in normalized castings. These are used in light and medium sections for oil-well tools, sheaves, sprockets, tractor shoes, gears, and cams. In heavier sections they are used in castings for locomotives, rolling-mill machinery, highly stressed gears, power shovels, and other machinery for rugged service.

4. Nickel-vanadium, nickel-chromium, and nickel-chromium-molybdenum quenched and tempered steel castings of high strength, hardness, and wear resistance. These steels are used for hardened gears, cams, rollers, sprockets, conveyor-chain links, oil-well tools, and sheaves.

5. Abrasion-resistant castings. Nickel-chromium and nickel-chromium-molybdenum steels are used to advantage where castings have to be of different



Pump and Engine Crankshafts Cast by Lebanon Steel Foundry from Chromium-molybdenum Steel of Unusual Strength



Gears Cast from Lebanon Chromium-molybdenum Steel of Great Strength, Ductility, and Wear Resistance

hardness in different sections, as, for example, in power-shovel teeth and impact hammers. They are also used for ore-chute liners, crusher jaws, dredge pumps, dipper teeth, etc.

6. Castings having great strength and creep resistance at elevated temperatures. Nickel-chromium and nickel-chromium-molybdenum steels are used for valves and fittings, return bends, and superheater and heat-exchanger heads.

A few typical examples of steel castings, as made by the Lebanon Steel Foundry, Lebanon, Pa., indicate the range of physical properties of castings now being made commercially. According to P. E. Gerhard of this company, crankshafts for engines, pumps, and other equipment cast from chromium-molybdenum steel are giving exceptional service. This steel, after heat-treatment, has a tensile strength of from 100,000 to 120,000 pounds per square inch, with a yield point of from 70,000 to 90,000 pounds per square inch. The elongation in 2 inches is from 17 to 24 per cent, the reduction in area, from 30 to 55 per cent, and the Brinell hardness, from 190 to 250.

A chromium-molybdenum steel having a carbon content slightly higher than that used in crankshafts is especially suitable for gears. Because of its greater hardness, it will withstand considerable wear. This steel, after heat-treatment, has a tensile strength of from 120,000 to 150,000 pounds per square inch, a yield point of from 85,000 to 110,000 pounds per square inch, an elongation in 2 inches of from 12 to 18 per cent, a reduction in area of from 18 to 30 per cent, and a Brinell hardness of from 250 to 300.

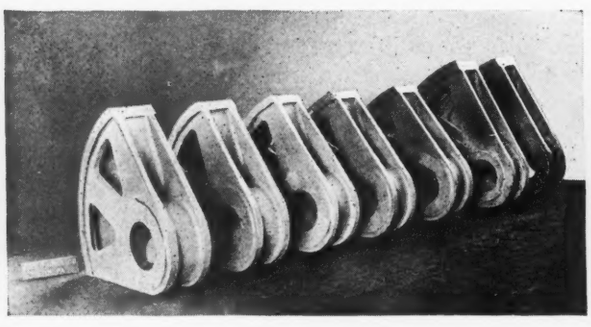
Cam castings may be made from several different grades of steel, depending upon the service requirements. They may be made either from chromium-molybdenum steel or from nickel-molybdenum carburizing steel. It is possible to obtain steel castings for this service with a Brinell hardness of from 500 to 600 in the heat-treated state. Of course, where such hardness is required, the castings must be machined before the final heat-treatment.

Nickel-steel castings containing from 1 to 4 per cent nickel are used for locomotive frames, rock crushers, high-pressure valves, steel-mill rolls, tube-mill balls, tractor and road machinery parts, gears, oil-field equipment, and cement-mill parts.

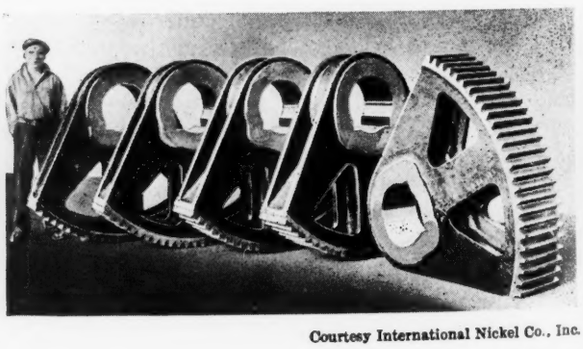
When corrosion resistance is an important requirement, steel castings may be made from an alloy containing from 4.5 to 6.5 per cent chromium, with a molybdenum content of approximately 0.5 per cent. This steel is used to a large extent in the oil industry because of its combination of high strength and resistance to corrosion.

Stainless-steel castings containing 18 per cent

Cast Nickel-chromium Steel Gear Segments for Butterfly Valves — Tensile Strength, 105,000 Pounds per Sq. In.



Same Gear Segments Finish-machined at Plant of Erie Forge Co.—Each Segment Weighs Nearly 5000 Pounds



Courtesy International Nickel Co., Inc.

chromium and 8 per cent nickel are also made for cases where a high degree of corrosion resistance is required. Castings of this type may, if necessary, be produced of a free machining quality.

In commenting upon improvements made in presses built by the Thomson-National Press Co. of Franklin, Mass., L. F. Remington, chief engineer of the company, refers to the use of cast steel in preference to cast iron in the platen of these machines. The reason cast steel was used was to obtain minimum deflection with sufficient strength and no added weight. The advantages gained by the use of cast steel are summarized by Mr. Remington as follows:

Typical Casting Poured from Titanium-treated Steel, with Ductility and Yield Point Greatly Improved

1. Reduced manufacturing costs, because of reduced handling costs, due to the relative lightness of the steel castings.
2. Weight reduction without a reduction in strength, because of the high tensile strength of the steel castings. Lighter sections of steel can also be used than formerly for a definite deflection.
3. Wear and breakage are greatly reduced by the increased hardness and strength of the steel.
4. The light, thin sections improve the appearance of the machine.

The steel castings referred to in the preceding paragraphs have a tensile strength of 75,000 pounds per square inch, an elastic limit of 45,000 pounds per square inch, an elongation of 22 per cent, and a reduction in area of from 30 to 35 per cent.

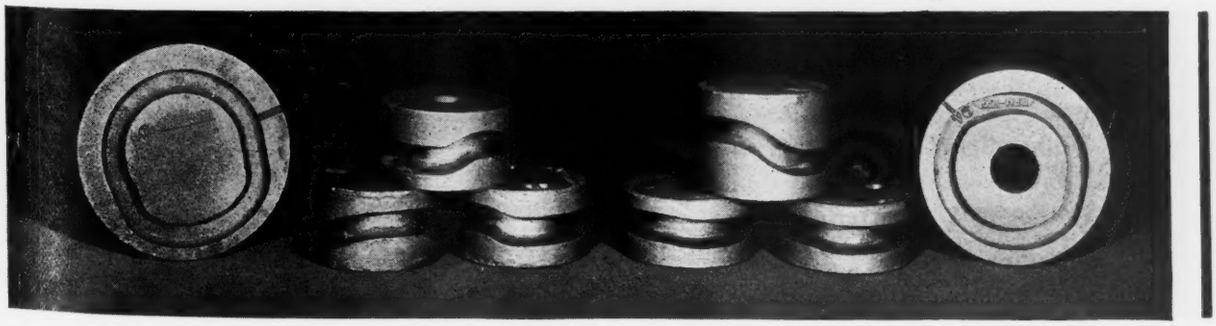
The flywheels of these presses are also cast from steel in order to make greater rim speed permissible. This procedure saved considerable expense in other design features, since a greater gear ratio would otherwise have been required. The large gears of the press are also made from steel castings. The operation of the machine as a whole has been improved by the elimination of dead weight. Increased speed and production have thus been obtained. Less power is required for operation, floor loads are decreased, the life of the machine is greatly increased, and maintenance costs are materially reduced.

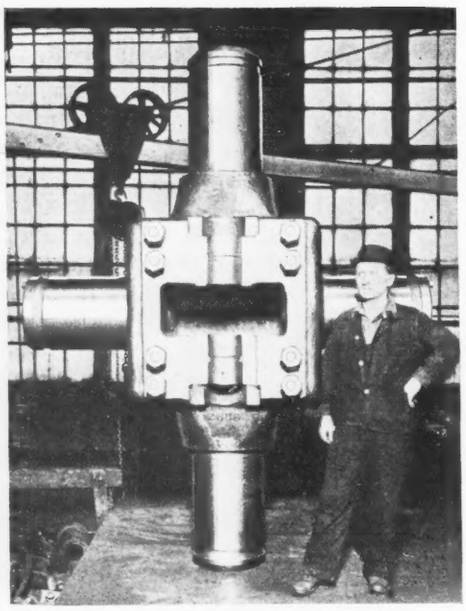
Among the many metals that are used in steel-making titanium has an important place. "Titanium makes good steel better" is the slogan adopted by the principal manufacturer of titanium for steel-making. Titanium has the effect of removing injurious gases and inclusions in steel castings and enables steel of any given chemical composition to be cast so that the best possible physical properties will be attained.

Probably the alloy most commonly used for this purpose in steel-making is ferro carbon-titanium, originally developed by the Titanium Alloy Mfg. Co. at Niagara Falls, N. Y. This alloy is used largely in steel for high-finished sheets, as well as in steel for castings, forgings, and rails. According to G. F. Comstock of the above company, it contains about 17 per cent titanium and 7.5 per cent carbon. It is added to the molten steel in the ladle, where it acts as a powerful deoxidizer. The titanium oxide formed acts as a flux on slag inclusions and causes them to rise out of the liquid steel.

Some interesting results have been obtained with titanium steel in tin plate used for cans in the canning industry. In one investigation, it was found that after twenty months' storage, 33 per cent of the cans made from ordinary steel had failed, whereas only 14 per cent of those made from titanium-treated steel were affected. In another test,

Cams for High-duty Service Made by Lebanon Steel Foundry. Chromium-molybdenum or Nickel-molybdenum Steels are Used for this Purpose





Courtesy International Nickel Co., Inc.

Huge Axle for Marion Electric Shovel Cast from Nickel-vanadium Steel Having a Tensile Strength of 90,000 Pounds per Square Inch

these percentages were 46 for ordinary steel cans, and 18 for titanium-treated steel cans.

In steel castings, improved yield point and ductility, as well as fewer defective castings, have resulted from the use of titanium-treated steel. In one test, it was found that the average yield point was increased nearly 6 per cent and the average ductility about 4 per cent by the use of three pounds of ferro carbon-titanium to each ton of steel.

Titanium does not remain in the finished steel, but acts simply as a deoxidizer, and is thus removed from the mixture.

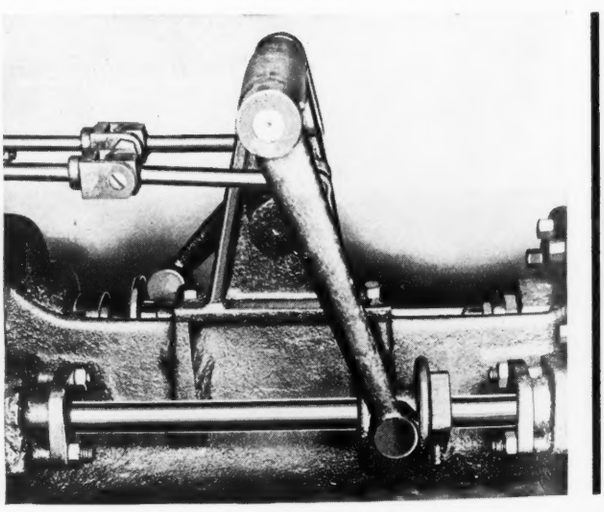
Monel Metal—a Remarkable Metal Alloy

Monel metal may well be considered one of the most remarkable of metal alloys. It consists of copper and nickel, but it is not made by melting these two constituents and mixing them together. Instead, Monel metal is a so-called "natural" alloy, made from an ore containing copper and nickel, no attempt being made to separate the two metals. As the cost of producing either nickel or copper from these ores is very high, the curious condition exists that the alloy Monel metal sells at a cheaper price than either of the two metals of which it is composed. The alloy possesses not only the general properties of nickel, but also unusual tensile strength. It usually contains from 24 to 28 per cent of copper and from 67 to 74 per cent of nickel, with small percentages of iron.

Monel metal is a metal of pleasing appearance, resistant to corrosion, and of excellent mechanical properties. It is available in both rolled and cast forms, and is used throughout industry wherever corrosion-resisting qualities are required—in aircraft, automobiles, and chemical plants, in the oil industry, in power plants, for marine purposes, and for numerous other applications.

This metal has found a place for itself in domestic uses—kitchen sinks, kitchen cabinets, range and table tops, and the like now being made from this material. The latest development in the use of Monel metal is for hot-water tanks or range boilers, and storage tanks for automatic hot-water heaters. The advantage of Monel metal for this purpose is that the tanks are rustproof and so highly resistant to corrosion that they will last for a great many years, even in hard-water regions where the use of water softeners is required and corrosion is generally a serious difficulty.

"Monel metal" is a registered trademark applied to an alloy containing approximately two-thirds nickel and one-third copper. It is produced and marketed solely by the International Nickel Co.



Monel Metal Pump Rods in Tannery of Gutman & Co., Chicago. After Eight Years Service, They are Still in Perfect Operating Condition

Aluminum, the Metal of the Present and the Future

Length of Boom Increased 25 Feet and Dead Weight Reduced 17,000 Pounds by Using Aluminum

WHAT has happened in the field of materials has, perhaps, never been better demonstrated than in the Travel and Transportation Building at the Century of Progress Exposition in Chicago, where stand, side by side, the first Pullman sleeping car, the old No. 9, and its 1933 counterpart. Aside from the many changes in design and equipment that have taken place in the three-quarters of a century since the No. 9 was built, there has been a marvelous change in the materials employed in car construction.

The first Pullmans were built of wood, wrought iron, and cast iron. In time, steel replaced the wrought iron and cast iron, and later, the wood. Each year, travel was becoming heavier and trains were being operated at higher speeds. Larger cars were required and the greater strength of steel made possible their construction, at the same time giving increased security in case of accident. But as the cars were made stronger and larger, their weight eventually reached a point where it was affecting the motive power, operating costs, and maintenance of equipment, permanent way, and structures.

Weight reduction was an economic necessity, and the characteristics of aluminum were such that a material reduction could be effected in the gross weight of the cars through its use without sacrificing the strength and safety developed during the all-steel era in car construction. Thus, in 1933—aluminum's tenth anniversary in railroad rolling stock—the first all-aluminum sleeping car, appropriately named the *George M. Pullman*, was built.

The *George M. Pullman* is about 85 feet long. With air conditioning equipment, an extra large generator, heavy batteries, and water supply, it weighs 96,980 pounds. A typical steel Pullman, of comparable size, weighs 172,000 pounds. Ten thousand pounds were saved in the trucks of the *George M. Pullman* due to their aluminization and to the fact that the lightness of the aluminum superstructure made possible a reduction in the size of the trucks from six to four wheels.

While this Pullman car and a de luxe type combination passenger coach, parlor-observation car, also being exhibited at Chicago, represent the first all-aluminum cars for main line service, aluminum has been employed in one form or another since its first application in 1923, in 2186 other cars and locomotives. The use of the metal in the two Century of Progress cars, therefore, was no idle experiment, but one based on sound engineering judgment and experience. Of the 2188 cars and locomotives in which aluminum has been applied, 927 are in service on the railroads and 1261 on electric street railways. In all, they have made possible the elimination of 1,300,000,000 ton-miles of dead weight!

Elevated railway trains are obviously well suited to aluminum construction. The New York Rapid Transit Corporation has recently awarded the Pullman Car & Mfg. Corporation a contract for the construction of a revolutionary type of elevated railroad train in which aluminum is largely used. The weight of the entire train will be 130,000 pounds—about one-half that of present trains with similar passenger capacity.

The applications of aluminum in railroad rolling stock construction were limited, up till 1929, by the size of the structural shapes and plate obtainable. Since then, mills have been built for the manufacture of large-sized structural shapes and plate and, as a result, 105 cars have been constructed with superstructures and under-frames completely fabricated from the strong aluminum alloys.

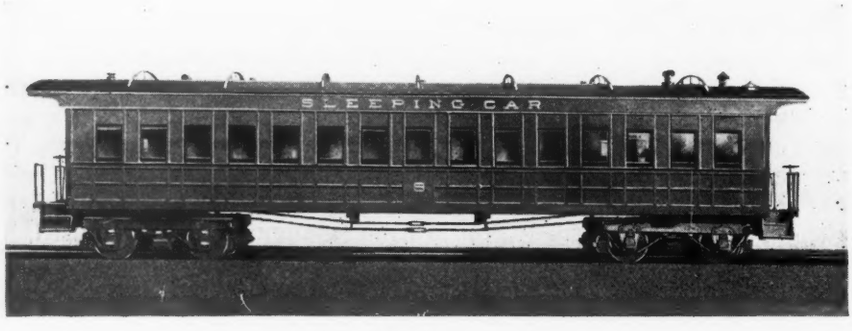
The scourge of dead weight is no respecter of industries, and in all, it has succeeded in exacting its toll. The work aluminum has done on the railroad is but one example of the manner in which

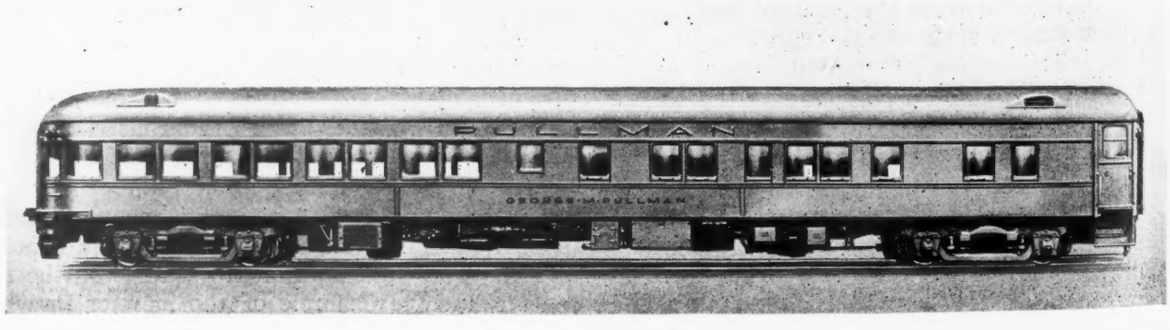
It is a Long Step from Aluminum Cranes and Railroad Cars to Jewelry to Meet Milady's Fancy—The Watch and Bracelet (97 Per Cent Aluminum) Weighs Less than One Ounce

this metal is combatting non-productive weight. Highway load limits have become more stringent, and each year the various states are placing greater limitations on the gross weight of the vehicles that can be operated on the highways. Some states are even imposing a ton-mile tax on commercial vehicles! Obviously, then, to increase the payload of a truck or bus, the dead weight of the chassis and body must be decreased, and in such cases, "aluminized" proves an appropriate synonym for "decreased."

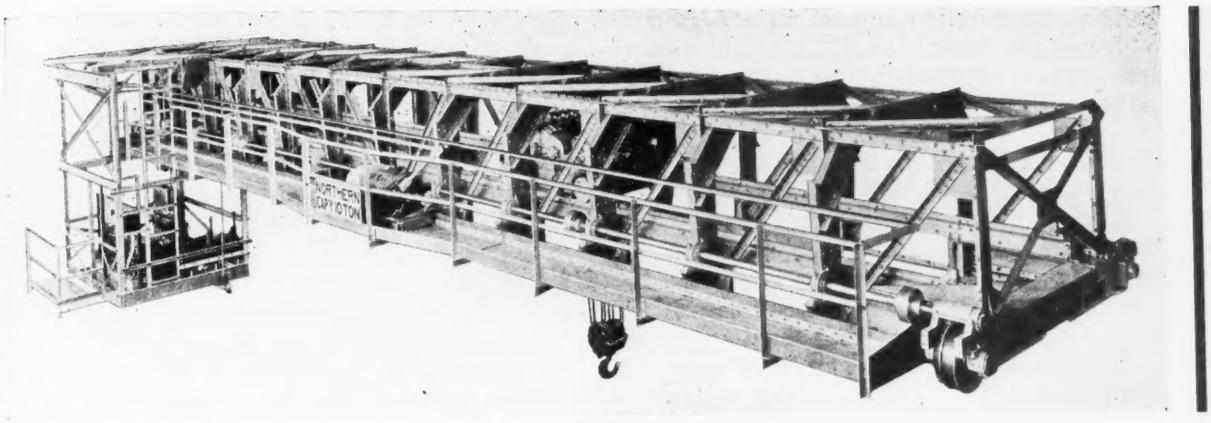
The story of the use of aluminum structural shapes and plate in truck and bus construction can best be told in terms of dollars and cents. An operator has a truck fabricated from the heavier materials. It has a payload capacity of five tons. He redesigns it, using an aluminum body. The payload is increased approximately a ton, but for this increase he pays between $400 and $500, because of the higher cost of aluminum. However, the aluminized truck is able to haul in five trips the same revenue load that the heavier truck hauled in six. The additional initial investment is soon written off, and by the end of the first year, it has paid a dividend of 150 to 200 per cent. Small wonder, then, that each year more and more trucks and buses are built from the light alloys!

Dead weight must go, whether it be in railroad cars, trucks and buses, or in the equipment of a contractor. Contracts are generally let with a time penalty clause. Days count. The work must progress smoothly and at a uniform rate. Picture the building of a Mississippi River levee or a large irrigation project in the West in which the dragline





First and Latest Pullman Cars—75 Years from Wood and Iron to Aluminum and Alloy Steel



Ten-ton Truss-type Crane with a Span of 76 Feet, Built from Aluminum and Weighing Only 15 Tons

excavators are invariably pushed to capacity. Anything that will increase their working radius and decrease the amount of rehandling necessary, without adversely affecting the mobility and stability of the excavator, speeds up operations.

Strong aluminum alloy structural shapes and plate again go to work. Their excellent strength-weight ratio permits an increase of 15 to 20 per cent in the length of the boom or of 20 to 25 per cent in the capacity of the bucket. Here is an example in point: A 150-foot all-steel boom, weighing 46,000 pounds when fully rigged, is replaced with an aluminized boom 175 feet in length, weighing only 29,000 pounds. With the boom operating at a 20-degree angle, the working diameter is increased 44.4 feet and the dumping height 6.6 feet, while the overturning moment is decreased approximately 9 per cent. And incidentally, as a result of this decrease in overturning moment, the counterweights can be reduced 25,000 and the total weight on the rotating parts 42,000 pounds.

In many industrial plants there has been a need, at one time or another, for greater capacity in the overhead traveling cranes, but to replace a 10-ton crane with a 25-ton crane might necessitate a reinforcement of the runways, and in extremely long buildings or in buildings with cantilever roofs, this is likely to prove a costly undertaking. The substitution of aluminum for the heavier materials commonly employed in crane construction will permit a larger capacity crane to operate on the same old runway. Conversely, it is possible to build lighter runways when an aluminum crane is used at the outset. Again, the chemical characteristics of aluminum may influence its use in the construction of cranes operating in plants in which the fumes and vapors are harmful to the ordinary materials.

Aluminum cranes may be either of the characteristic box-girder type or of the truss type. In general, the latter type is preferred, since the saving in material more than offsets the higher cost of fabrication. With the cheaper materials, it is, of

Pitching and Painting are Unnecessary with Aluminum Beer Barrels. Half-barrel Container Weighs Only 21 Pounds

course, less expensive to use more material and less labor—hence the box-girder type crane. But regardless of labor costs, aluminum's principal job is to lighten the dead weight of the crane, and a truss type crane can be built with a greater ratio of live load to dead load than the box girder type.

In contrast to these few illustrations of heavy-duty applications for aluminum, there is another side to the story of this metal. From dragline excavators to wrist watches is a big jump, and it is an equally broad jump from railroad cars to collapsible tubes for tooth paste and shaving cream—yet aluminum has bridged the gap. Available in all the forms known to the metal-working art and endowed with outstanding physical and chemical characteristics, its applications are innumerable.

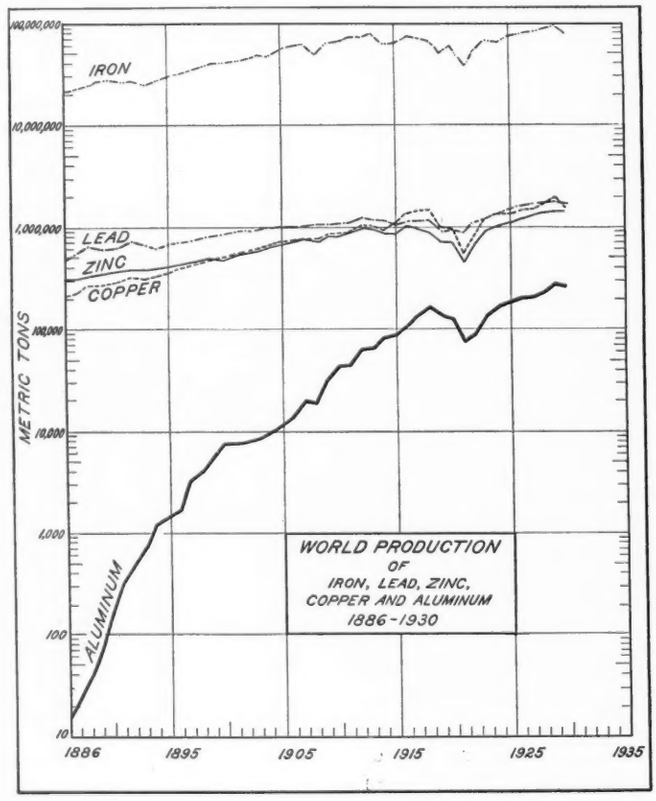
Aluminum is not an old metal. At the time George M. Pullman built the No. 9 car, aluminum was classed among the precious metals. It was discovered in 1825 by a Danish scientist, H. C. Oersted, and, until Napoleon III came on the scene, it was more or less an obscure plaything of scientists. But it was light—an ideal material for helmets! Accordingly, Napoleon commissioned Deville, a French chemist, to find out how to make aluminum in sufficiently large quantities to outfit France's standing army without increasing her national debt. But Napoleon had to content himself with buttons for his own uniform and an aluminum table service for his regal guests. Deville's work was not in vain, however, for it started aluminum on its way as a commercial metal. In four years (from 1852 to 1856), the price of aluminum dropped from $545 to $34 a pound. Pullman's first car, if made of aluminum, would have cost more than $1,000,000!

For the next thirty years, price reduction was by no means so great. In 1886, aluminum was worth about $8 a pound. It had thrown off its aristocratic cloak and become a semi-precious metal. Deville's process was still in use, but his method of producing aluminum was purely chemical in nature; scientists in both Europe and America realized that something had to be done if aluminum was to compete with iron and steel, or brass and bronze—the everyday metals of commerce. On February 23, 1886, Charles Martin Hall, less than a year after his graduation from Oberlin College, developed the present electrolytic process for the production of aluminum. About the same time, Paul L. T. Heroult, a young Frenchman, working independently, developed substantially the same method.

Aluminum's commercial history, therefore, dates from the discovery of the Hall-Heroult process. Starting at scratch, so to speak, only forty-seven years ago, the metal today ranks fifth in tonnage among metals. Its world production is surpassed only by iron and steel, copper, lead, and zinc.

Research and development have contributed largely to the success of aluminum, but underlying all research and development are certain inherent characteristics of the metal that make its need felt and appreciated—its light weight, high thermal and electrical conductivities, non-toxic qualities, excellent corrosion resistance, and the ease with which it may be worked.

The information in this article has been obtained through the cooperation of Douglas B. Hobbs of the Aluminum Co. of America.



Comparison of World Production of Iron, Lead, Zinc, Copper, and Aluminum in the Years 1886-1930

Synthetic Plastics Solve Many Problems in Materials

THE solution of many problems in the selection of materials has been found in the use of synthetic plastic products, of which there are many different varieties available. Used only to a very limited extent a few years ago, these materials have now found universal application. The many forms in which they are available, both as regards appearance and physical properties, make them suitable for an extremely wide range of mechanical applications, as well as for ornaments and objects formerly made from metal or wood.

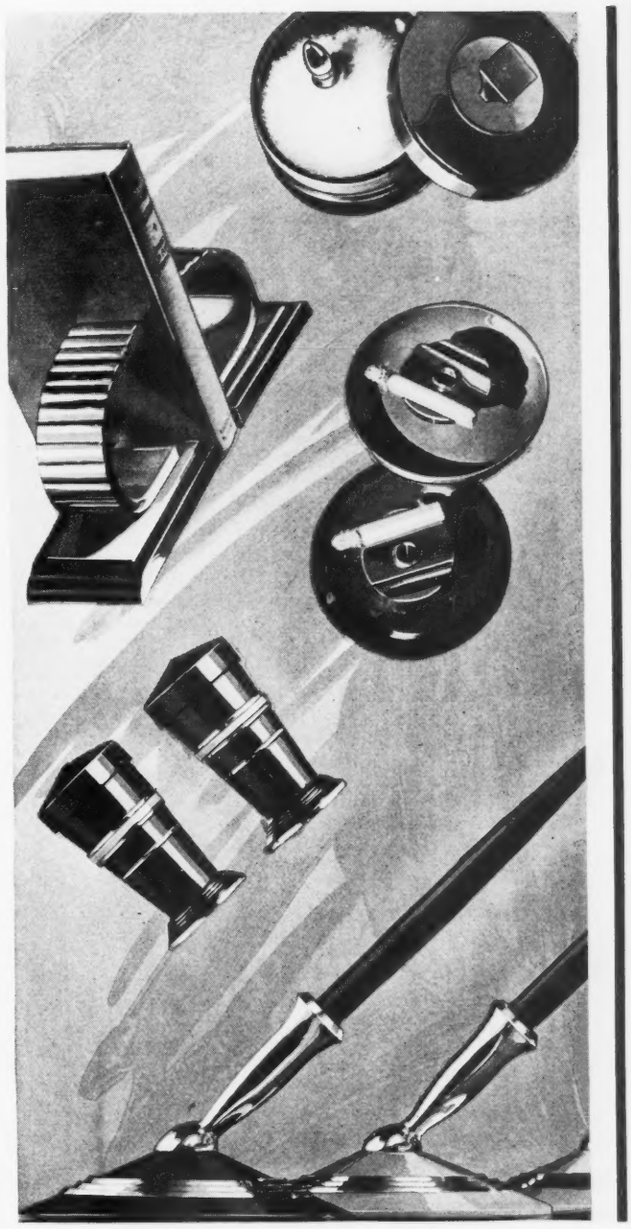
Most of the plastic materials are obtainable in either powdered or sheet form, depending on the application for which they are intended. The most widely used type is that designed for molding into the final finished form. In general, the parts as they come from the mold require little or no additional work, and usually have a high and permanent gloss to which no enamel or other finish need be applied.

Many designers and engineers used to think of plastics simply as materials to be used when electrical insulation was required, but while plastics are still used as one of the most important materials for this purpose, that is no longer their chief application. Thousands of other uses have been found for objects made from these materials—household articles, ornaments and novelties, and machinery parts. Recently a new impact material has been developed by the Bakelite Corporation that is suitable for machine parts, instrument cases, and other devices that are subjected to severe service.

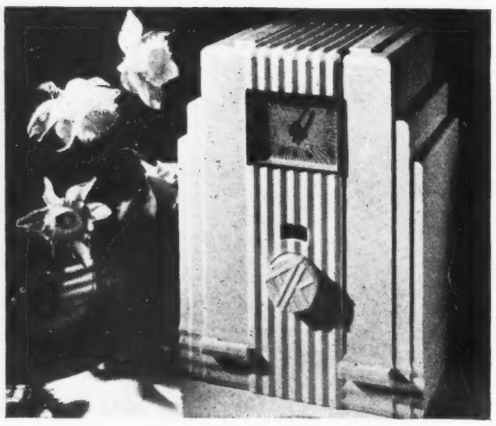
The most generally used plastic materials may be divided into nine classifications. Each of these materials has characteristics different from the others; and while the field of application overlaps in some cases to a considerable extent, nevertheless there are certain definite applications for which each plastic material is particularly well suited.

As classified by G. K. Scribner, president of the Boonton Molding Co., these nine types of plastics are: (1) Molded phenolic compounds; (2) cast phenolics; (3) laminated phenolics; (4) cellulose acetate; (5) urea compounds; (6) casein; (7) cold-molded compounds; (8) hard rubber; (9) shellac.

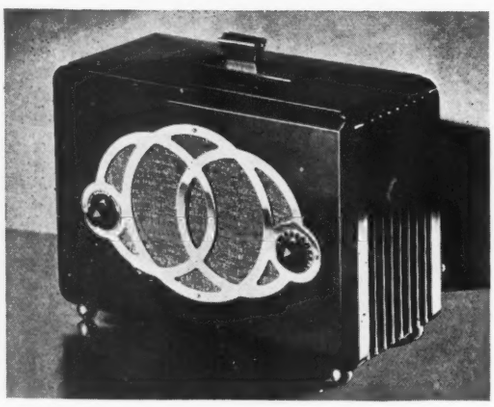
The most universally used plastic materials are the *molded phenolic compounds.* In these compounds various materials are used as fillers—wood flour, asbestos, canvas, mica, etc.—each giving to the compound a special characteristic. Canvas produces strength; asbestos is used when the final product has to be exposed to heat or water; mica produces



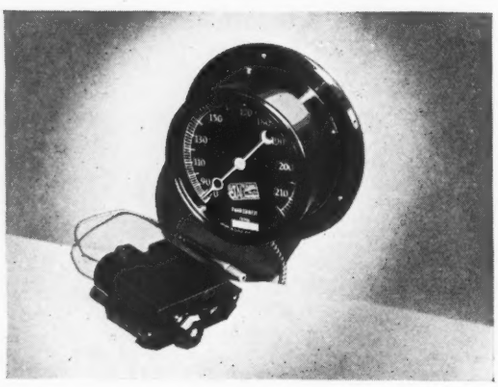
A Group of Novelties in which Zinc Die-castings and Molded Plastics are Used in Combination. The Colors of the Chromium, Copper, and Brass Plating Contrast Well with the Base Color of the Plastic Parts—Black Durez in This Case



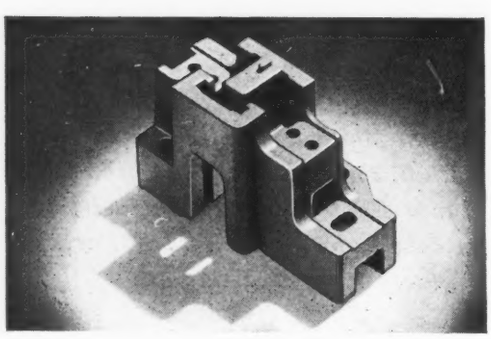
Air King Radio Cabinet Molded in Plaskon, a Product of the Toledo Synthetic Products, Inc. Light Weight, Strength, and Resistance to Acids, Water and Grease are Among the Advantages



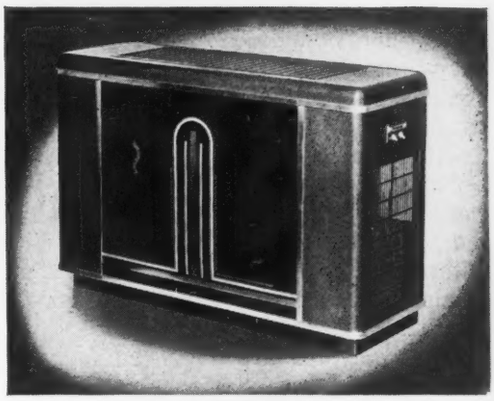
Chromium-plated Zinc Die-castings and Molded Plastics Combine to Complement the Values of Each Material —a Colonial Radio Cabinet Made from the General Plastics Black Durez



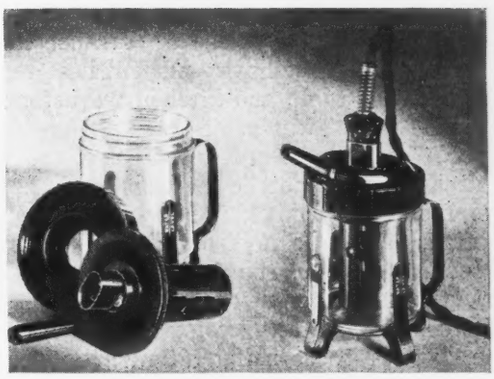
The New Tagliabue Dial-indicating Thermometer and Snap-on Controller for Refrigeration Service Made for Severe Operating Conditions with Black Molded Bakelite Cases



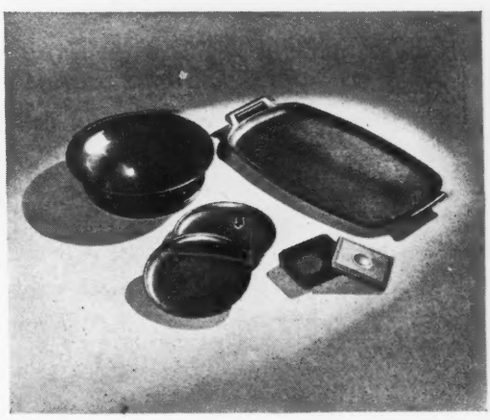
An Intricate Molded Part for Electrical Equipment Molded from Non-refractory Cetec, Made by the General Electric Co.—Typical Application of One Type of Cold-molded Material



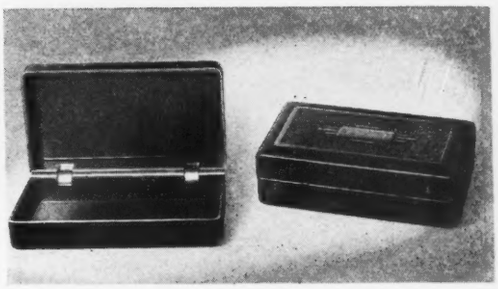
Westinghouse Air Conditioning Unit, Designed by the Company's Art Director, D. R. Dohner, and Made from Lustrous Black Micarta Panels with Decorative Metal Inlays—Photograph, Courtesy Bakelite Corporation



Glass, Metals, and Plastics are Combined in the New DeVilbiss Atomizer to Make a Sturdy, Foolproof Appliance for the Home—The Plastic Parts are Molded from Black Durez



Several Examples of Attractive Objects Molded from a New Rubber-base Thermo-plastic Known as "Plioform." This is a Material Recently Developed by the Goodyear Tire & Rubber Co.



Bakelite Molded Boxes with Triplex Spring Hinge Devised by the Rathbun Mfg. Co., Lockport, N. Y., to Reduce Production Costs and Improve Appearance—Photograph, Bakelite Corp.

dielectric properties; while the wood-flour base is used for general purposes.

Cast phenolics are expensive, but very beautiful, both in surface finish and color combinations. They are especially suitable for simple forms that can be cast with little or no finishing, where a beautiful appearance is the first requirement.

Laminated phenolics have a broad field, as they can be given a surface that is a fine imitation of onyx, marble, or wood. They make excellent facing materials. Their great strength and good machining qualities are also in their favor.

Cellulose acetates are used primarily for their appearance, and secondarily, for their strength. They are rather expensive, however, and have a low heat resistance.

The *ureas* are filling a definite field in a rapidly increasing volume. All the colors of the rainbow, with depth of surface and translucency, give them a marked advantage where appearance is an important factor. They have sufficient heat resistance to be used for table and kitchen ware that has to be washed in hot water.

Casein has the advantage of color, the same as the ureas, but cannot be molded. It is a product made from milk, mixed with pigments or filling materials. Casein cannot be molded, but is sold in the form of sheets, rods, and tubes. Its largest application is in the button industry.

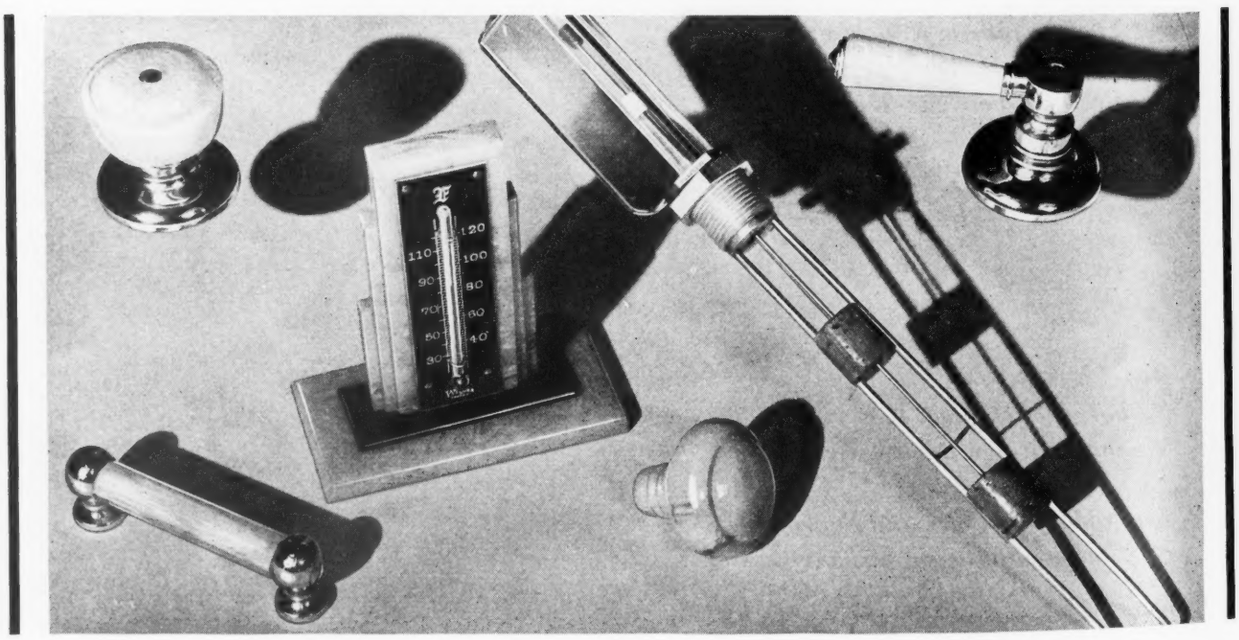
The *cold-molded compounds* can be grouped into three classes—those using bitumen binders, those using cement binders, and those using resin binders. Products made from these compounds are extremely high in heat resistance, but are more brittle and have less strength than some of the other plastic materials. For small production, the tool costs are comparatively low. The bitumen-binder type is the least expensive and is largely used for parts requiring a high degree of plastic molding. The cement-binder type has greater physical strength and high resistance to heat and electric arc. Its cost is relatively high. The resin-binder type has greater physical strength but less heat-resisting qualities than the bitumen-binder type.

Hard rubber has been used so long and for so many different purposes that its advantages and disadvantages are fairly well known. The natural color of hard rubber is black, but it can be obtained in red, green, blue, violet, brown, gray, and mottled colors.

Shellac as a binder in a molding compound probably outdates any other binder known. As fillers, many different materials may be used, the most common ones being asbestos, mica, marble flour, and wood flour. The applications of shellac materials are widely diversified. Insulators of practically every description, some of them probably the largest molded pieces ever produced, down to knobs, handles, and buttons, are made from this material. The finish is excellent and the parts take a high polish.

The advice of experienced molders as to the best plastic material for a specific purpose is always of value to prospective users of these materials.

Door Handles, Faucets, Furniture Trimmings, and Instrument Settings Made from Catalin, a Colorful Cast Synthetic Plastic Available in Rods, Sheets, Tubes and Castings—Courtesy American Catalin Corporation



Drawn and Extruded Shaped Bars and Wire

The Machine Designer of Today Effects a Considerable Saving in Costs by the Use of Shaped Stock

ALTHOUGH the practice of producing small parts by cutting shaped bar stock into short lengths has advanced rapidly in certain industries during the last few years, machine designers in general are not aware of the great variety of shapes and materials in which bar stock is now made, nor do they realize the many advantages these materials offer in the production of small parts. The accompanying illustrations show typical examples of shaped stock now used extensively for machine parts, ornamental purposes, and structural work. Many parts made from these materials are ready for use as soon as they have been cut off to the required lengths, while others need some machining.

In addition to the shapes produced regularly, some manufacturers make a specialty of producing shapes to suit their customers' specifications. One manufacturer maintains a staff of metallurgists and engineers to serve manufacturers in their own plants. These men assist in the solution of problems pertaining to steel analyses, physical properties, heat-treatment, and machining operations, with a view to improving the product and obtaining greater economy through the use of shaped bars. Many applications that originally seemed impracticable to the manufacturer, from the standpoint of economy, have been worked out successfully by this staff of trained men.

Fig. 1 conveys some idea of the great variety of cold-drawn steel shapes now available. The shapes are not shown to size nor to the same scale, the object being merely to show as many different shapes as possible in the space available. In 1927, the Union Drawn Steel Co. began extensive publication of bulletins and periodical advertising calling attention to the possibilities of drawn steel shapes. The response to this educational program greatly exceeded expectations, and as a result, the special shapes produced in 1931 amounted to an appreciable percentage of the company's total production of cold-drawn material. This is of especial interest in view of the fact that the company's production of cold-drawn steel for 1931 showed an increase of 70 per cent over the previous year.

These shapes are usually held to size within plus or minus 0.002 inch, but in some cases, accuracy can be maintained within 0.001 inch of the required size. Electrical generators, steam turbines, typewriters, sewing machines, printing presses, and textile machines are typical products in which parts made from these cold-drawn steel shapes are used.

The company producing the typical cold-drawn steel shapes shown in Fig. 2—the Anchor Drawn

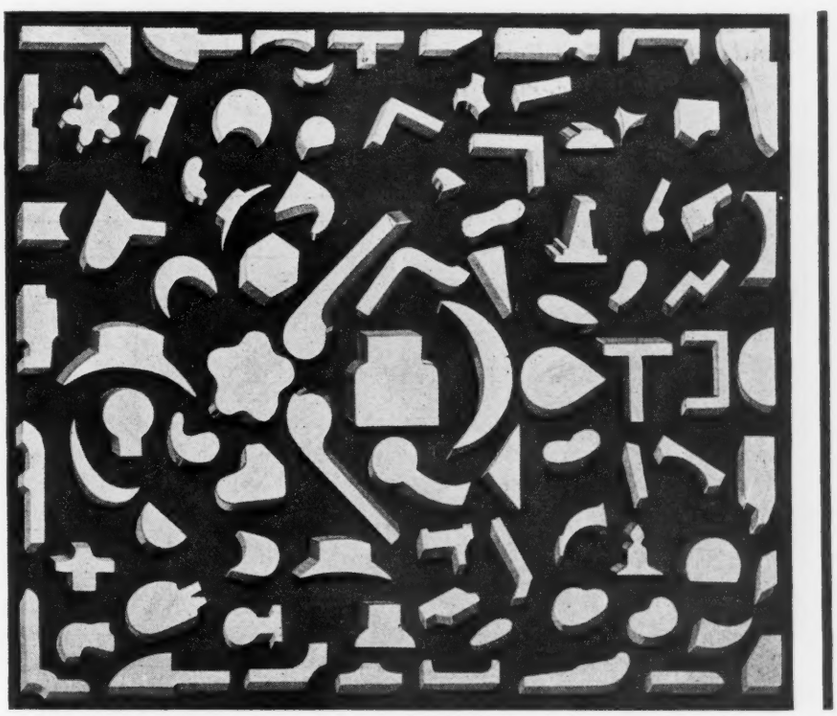


Fig. 1. Group of Special Drawn Steel Shapes Used for Machine Parts, Ornamental Designs, Structural Work, and Other Purposes—Produced by the Union Drawn Steel Co.

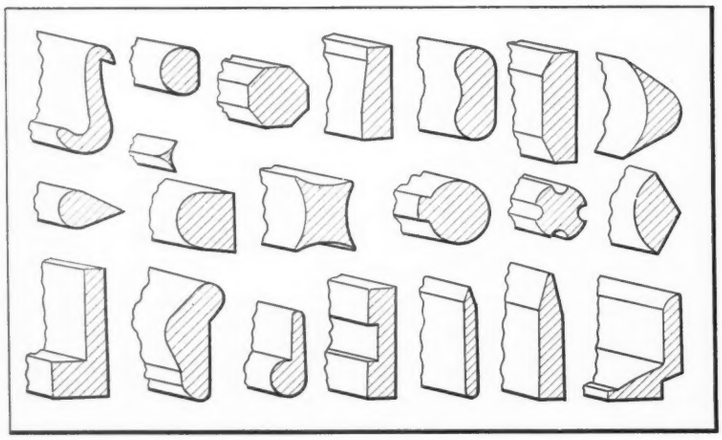


Fig. 2. Typical Shapes of High-speed, Alloy, Stainless, Carbon, and Special Steels, Cold-drawn to Size by the Anchor Drawn Steel Co.

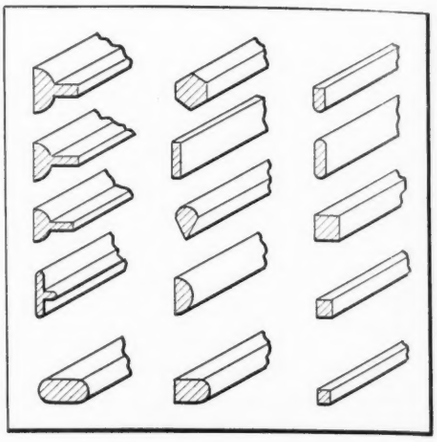


Fig. 3. Shapes of Wire Available in a Variety of Sizes, Finishes, and Tempers as Drawn by Wickwire Spencer Steel Co.

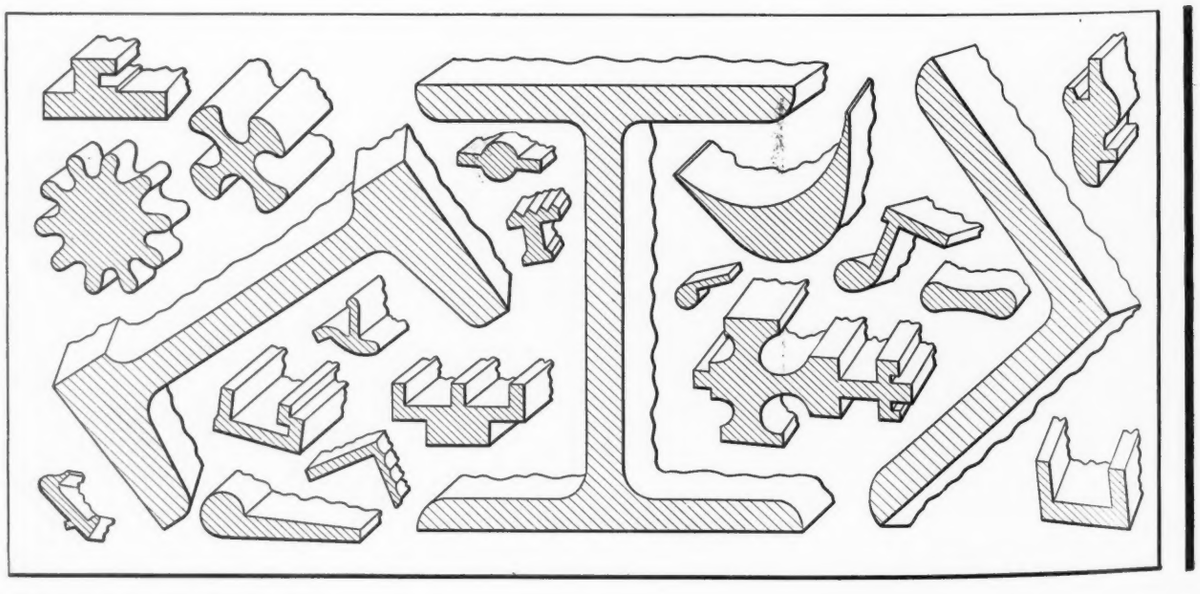
Steel Co.—is equipped for cold-drawing special shapes in high-speed, alloy, stainless, carbon, and special analysis steels.

In Fig. 3 are shown some of the regular and odd-shaped wires made by the Wickwire Spencer Steel Co., a concern that draws a variety of shaped wires in different sizes, finishes, and tempers.

Rods and bars of brass and bronze alloys are made economically in odd and irregular forms by the extrusion process. Some of the shapes made by the American Brass Co. are shown in Fig. 4. Short lengths cut from shaped rods of this kind are now being used extensively in place of castings for many small parts. Long lengths of extruded shapes are used for ornamental and structural purposes. These rods and bars are smooth, accurate in dimensions, and require little finishing. They have a tensile strength of over 50,000 pounds per square inch.

Some of the shapes of extruded brass rod made by the Scovill Mfg. Co. are shown in Fig. 5. The use of shaped rod of this kind is simplifying many machining operations, and has reduced the fabrication costs on many products. Extruded shaped rods are produced by forcing the heated metal under pressure through dies having openings the size and shape of the piece required. When extruded shapes have to be machined, they may be made from a free-cutting brass.

Fig. 4. Cross-sections of Typical Anaconda Brass and Bronze Alloy Rods and Bars Produced by the Extrusion Process by the American Brass Co.



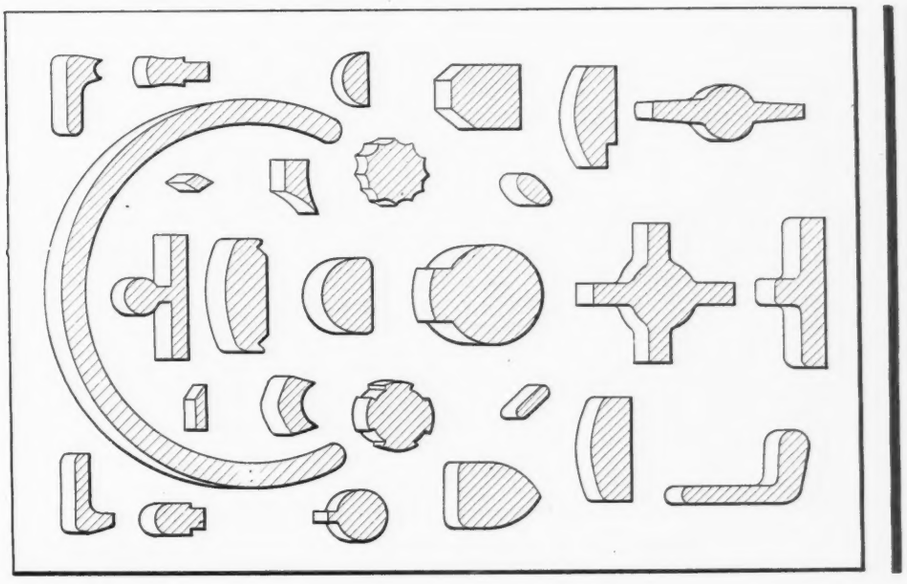
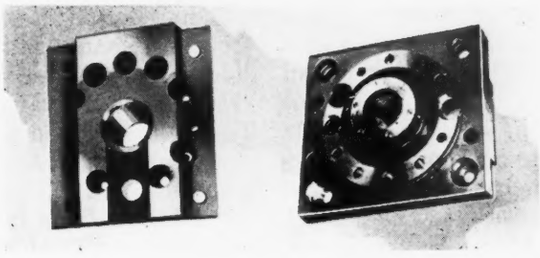


Fig. 5. Shapes of Extruded Brass Rod Made by the Scovill Mfg. Co.

Tool Steel as a Material for Machine Parts



Tool Steels are Used for Machine Parts as well as for Cutting Tools—Bolt Machine Parts Made from "Stentor" Non-shrinking Tool Steel

IN the machine-building industries, the term "tool steel" is applied to any steel that is suitable for cutting tools or to any steel that contains sufficient carbon to permit it to be hardened by heating above a certain temperature and quenching. Tool steels, however, are used for many purposes other than cutting tools. For example, straight carbon tool steel drill rod having a carbon content of from 1.00 to 1.20 per cent was developed primarily as a material for cutting tools such as drills, taps, and punches, but great quantities of this material are also used for shafts and other working parts of innumerable small machines, such as typewriters, adding machines, sewing machines, and various household appliances.

Drill rod probably has more diversified applications than any other form of tool steel, yet comparatively few designers take full advantage of its many possibilities in machine construction. High-carbon tool steel in the form of drill rod can be obtained either polished or unpolished in sizes from 1/64 to 1 1/2 inches, varying by sixty-fourths, and also in the "letter" and "number" sizes.

Square drill rod stock is made in sizes from 1/16 to 1/2 inch, varying by thirty-seconds. High-speed steel drill rod is kept in stock in sizes ranging from 1/16 to 1/2 inch, by sixty-fourths, and for all letter sizes and number sizes from 1 to 52, inclusive. Some drill rod is held to a limit of 0.00035 inch above and below the specified sizes. This permits its use when accurate fits are required without further sizing or finishing.

Formerly all high-grade tool steel used for cutting tools was made in air-tight crucibles. Today the electric furnace is used extensively for this purpose. Steel for many of the cheaper grades of tools and implements is made by the open-hearth process. This material is also known as tool steel, but can be used advantageously for many purposes other than tools.

The ball-bearing steels, which are, in general, manufactured by tool steel concerns, and which are classified as tool steel, are used almost wholly for machine construction purposes, and the same might be said of magnet steels and valve steels. The steels

Examples of Uses of Tool Steel for Machinery Parts

The Ludlum Steel Co., Watervliet, N. Y.

Application	Kind of Steel	Reason for Use
Arbors	Carbon, 1.00–1.10; Chromium	Must resist wear and hold size
Ball-bearing Balls, Rollers, and Races	Chromium Bearing	Must resist wear and have high compressive strength
Bushings	Carbon, 1.00–1.10; Chromium Bearing	Must resist wear, have high compressive strength, and hold size
Cams	Chromium Bearing	Must resist wear, have high compressive strength, and hold size
Collets	Carbon, 1.00–1.10; Chromium-Molybdenum	Head must resist wear and shank have good spring quality
Chuck Jaws	Carbon, 0.80–0.90; Vanadium	Must resist wear and shock
Lathe Centers (Ordinary) Severe Service	Carbon, 1.00–1.10; High-Speed; High-Carbon–High-Chromium	Must resist abrasion
Clutch Disengaging Pins on Presses	Vanadium; Chromium-Tungsten	Must resist shock and wear
Heavy-duty Studs	Carbon, 0.80–0.90; Molybdenum; Tungsten	Must resist wear and have high physical properties
Holders for Certain Design Thread Chasers	Oil Hardening	Must resist wear and harden without distortion
Holders for Gang of Punches	Oil Hardening	Must resist wear and harden without distortion

used for balls, rollers, and races, and for other parts that must resist wear and be subjected to heavy compression without much shock, are deep hardening tool steels with a high degree of hardness.

Chrome-vanadium steels, varying in carbon content from 0.45 to 1.00 per cent, which in many instances were intended strictly as tool steels for punches, die-heads, shear blades, etc., are also widely used for grinding-machine spindles, spiral-type gears, collets, and many other parts used in machines and structural work.

The high-speed steels developed for cutting tools also have many applications as construction materials, typical examples of which are springs, collets, and feed-fingers for automatic screw machines; guide pins on die sets; lathe centers; cams and cam rolls; clutch pins and valve seat inserts in automobile engines.

The 18 per cent tungsten high-speed steel is used in considerable quantities for springs in household electric utensils, such as irons and toasters, and for numerous other purposes where other steels would lose their resiliency at the high temperatures to which they are likely to be exposed in use.

The carburized or nitrided steels are often used for parts that must resist wear and hold their size closely, as for example, arbors, bushings, cams, punch-holders, shafts, and rollers. The tool steel thus used may be either a 1.00 per cent carbon, water-hardening, or a manganese oil-hardening type, the latter being used when distortion is a factor.

A number of alloy steels that were developed by tool steel manufacturers and were formerly considered tool steels have been absorbed in recent years under the various groupings of S A E steels. The most outstanding of these are the well-known chromium-vanadium and carbon-molybdenum combinations, and the 1 per cent carbon, 1.50 per cent chromium die and bearing steel. These steels are now made by production methods that make them available for a wide range of applications which would not warrant the use of the higher priced, high-grade tool steels.

In preparing this outline of typical applications for tool steel in machine construction, the assistance rendered by the Ludlum Steel Co., the Vanadium Alloys Steel Co., the Carpenter Steel Co., and the Firth-Sterling Steel Co. should be acknowledged.

Cast Iron, an Old Metal with New Possibilities

In the Forward March of Materials, Cast Iron has not Stood Still. Constant Research has Provided New Cast Irons with New Qualities

THE ease of casting and the adaptability to machining operations are two characteristics that have established cast iron as one of the most widely used engineering materials of the machine age. These properties have made this metal a most willing servant of the designer, enabling him to meet the needs of both heavy construction and intricate designs. The so-called "high-strength" cast irons have created a new place for themselves in the metal industries, and the ordinary grades of gray iron have been vastly improved to meet new requirements.

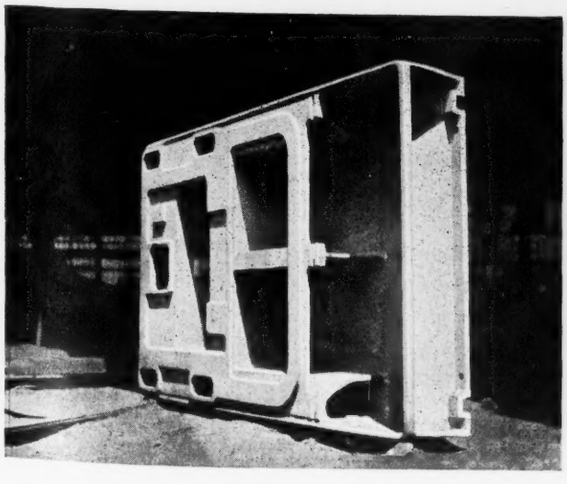
In commenting upon modern gray iron, W. W. Kerlin, metallurgist of the Gray Iron Institute, points out that it is only within recent years that the full possibilities of cast iron have been thoroughly appreciated, many properties having been revealed that were previously unknown to the engineer and designer. Perhaps the most outstanding advance that has been made in this field is the recognition by the designer of a point which metallurgists have long appreciated—that is, that cast iron is not just one material, but a family of materials, the members of which can be classified into groups serving entirely different sets of conditions. The American Society for Testing Materials, in its specifications, divides gray iron into seven groups, according to minimum tensile strength, as follows:

Class 20	20,000 pounds per square inch
Class 25	25,000 pounds per square inch
Class 30	30,000 pounds per square inch
Class 35	35,000 pounds per square inch
Class 40	40,000 pounds per square inch
Class 50	50,000 pounds per square inch
Class 60	60,000 pounds per square inch

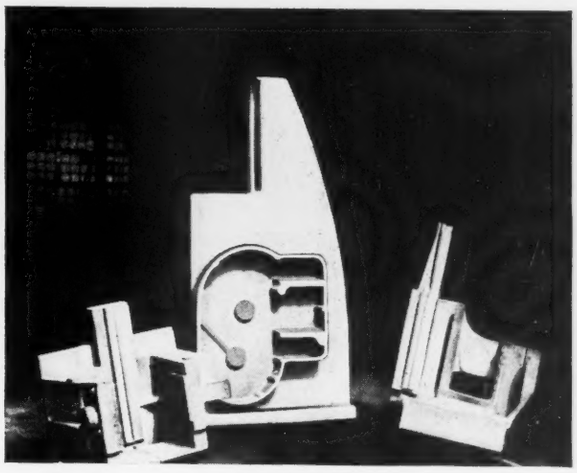
At the left below is illustrated a bed casting weighing 15 tons. Here soundness, rigidity, and good machineability were the main requirements; hence, a Class 30 iron was used without alloys. The tensile strength was 36,000 pounds per square inch for a 1.2-inch diameter test bar, and 33,000 pounds per square inch for a 2-inch diameter bar. This indicates the comparatively small effect of mass on the physical properties of this iron. In this casting, care has been taken to use as uniform sections as possible throughout.

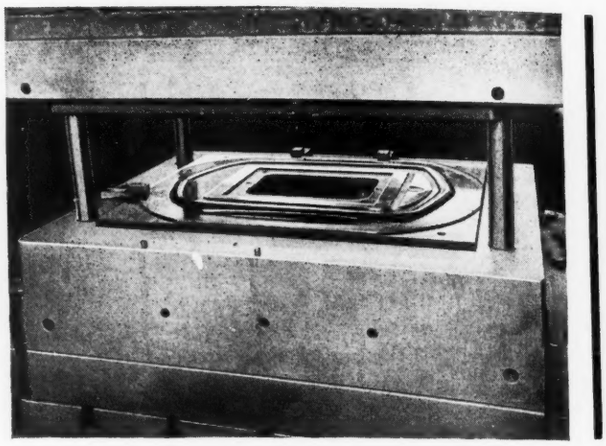
At the right below are shown three machine tool castings weighing from 350 to 1500 pounds, which are made from the same metal as the bed. An iron free from the sudden effects of chill was required to avoid difficulties that might be encoun-

Fifteen-ton Bed Casting Made by Johnston & Jennings Co., Cleveland, Ohio, from a Cast Iron Having a Tensile Strength of About 35,000 Pounds per Square Inch



Three Machine Tool Castings Weighing from 350 to 1500 Pounds, also Made by Johnston & Jennings Co., from the Same Kind of Cast Iron as Bed to the Left





Ford Radiator Shell Forming Die Weighing 575 Pounds, Made from Heat-treated Chrome-nickel Iron and Machined after Heat-treatment—Courtesy International Nickel Co.

tered in machining the gear housing of the center piece. The making of an intricate casting of this kind is justified by the added rigidity and reliability of a machine tool made of as few integral parts as possible.

Superior gray irons may be produced in any one of the following ways or by a combination of these methods: (1) Special melting methods; (2) use of special alloys; (3) special practice in molding and pouring; (4) improved technique and supervision.

The growth in the use of the higher grades of cast iron has been extremely rapid. It is estimated that in 1925 not more than two foundries in a hundred in the United States produced alloy cast iron. In 1932, according to F. B. Coyle, of the International Nickel Co., fully 22 per cent of all the foundries in the United States and Canada made alloy cast iron.

Who would have thought only five years ago of cast-iron crankshafts for Diesel engines and automobiles. Yet, today, the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., has been making crankshafts for a period of about two years for Diesel-engine manufacturers, while several of the larger automobile builders are using these crankshafts experimentally. The company mentioned states that up to the present time there have been no failures, but only the most favorable comments and reports.

The crankshafts are made from a nickel-molybdenum-alloy iron in an electric furnace. This iron has an unusually high tensile strength and exceptional wearing qualities on the bearing surfaces. The ultimate tensile strength is about 60,000 pounds per square inch, while the ultimate compression strength runs up to 150,000 pounds per square inch. The hardness is about 280 Brinell.

By the use of nickel, chromium, and molybdenum in comparatively small percentages in cast iron, the tensile strength of castings has been doubled and even trebled. Alloy castings having a tensile strength of from 30,000 to 45,000 pounds per square inch are made regularly, and alloy cast iron with a tensile strength as high as 65,000 pounds per square inch has been produced. These alloy cast irons, in addition to having greater strength, are also considerably harder, as a rule, than the ordinary gray-iron castings.

As a specific example may be mentioned a nickel-chromium cast iron containing from 2 to 2.5 per cent nickel and from 0.2 to 0.3 per cent chromium which has a tensile strength of from 40,000 to 50,000 pounds per square inch, with a hardness of up to 240 Brinell.

There are several high-strength cast irons known by trade names. One of these, trade-named "Meehanite," made by the Farrel-Birmingham Co., Inc., Ansonia, Conn., has, as cast, a tensile strength of 50,000 pounds per square inch. By heat-treatment, this may be increased to over 70,000 pounds per square inch.

Nickel cast irons containing from 0.5 to 3 per cent nickel are used in automobiles, oil and gas engines, locomotives, compressors, pumps, machine tools, and textile machinery, as well as for cut gears and cams, glass molds, and forming dies. Cast iron with a nickel content of from 3 to 5 per cent is used for resistance grids, heavy stamping dies, and parts that are first machined and then given a heat-treatment for high hardness.

A nickel content of from 10 to 15 per cent is used in cast irons for electrical machinery where non-magnetic, high-resistance qualities are required. Corrosion-resistant cast irons are also available with from 12 to 30 per cent nickel. These are non-magnetic cast irons used in oil-refinery equipment, automobile and Diesel engines, valves, and chemical equipment.

Both drawing and forging dies are now being made to an ever increasing extent from heat-treated nickel-chromium cast iron. According to F. B. Coyle, of the International Nickel Co., four different grades of alloy cast iron are used for such dies. Grade No. 1, containing from 1.25 to 1.75 per cent of nickel and from 0.50 to 0.75 per cent of chromium, is used for light duty, such as the drawing of the bodies and fenders of automobiles from thin sheets.

The next grade, containing from 2.5 to 3 per cent of nickel and from 0.60 to 1 per cent of chromium, is used for somewhat heavier work with relatively deep draws. Dies of this grade of cast iron have

drawn from 16,000 to 18,000 fender and body parts, as compared with 3000 blanks with ordinary cast-iron dies. In one instance, 50,000 chassis channel blanks were drawn with an alloy-steel cast-iron die of this type.

The third grade, containing from 1.5 to 2 per cent of nickel and from 0.25 to 0.50 per cent of chromium, is especially intended for heavy duty, since it has a high tensile strength. In one instance, 126,000 fender and body sheets were drawn by dies of this grade, while only 12,000 were drawn by dies made from alloy cast iron of the first grade, and only 3000 by ordinary cast-iron dies.

A fourth grade, containing from 5.5 to 6 per cent of nickel and from 0.50 to 0.60 per cent of chromium, is used for extremely heavy duty dies. One of these dies was still in good condition after having drawn over 8300 steel brake-drums. Dies made from the second grade of alloy cast iron stood up for only 1500 brake-drums, while ordinary cast-iron dies broke down after 800 drums had been drawn.

Charcoal Pig Iron Improves Quality of Many Castings

In the early history of iron-making, all castings were made from charcoal pig iron. In spite of the developments in metallurgy, this type of pig iron has continued to hold its own for many purposes, and it is safe to say that it will probably always be used in certain kinds of castings.

Primarily, charcoal pig iron is used at the present time in the manufacture of chilled rolls. It is also particularly suitable for other products that require a chilled surface for strength and hard, resistant wearing qualities, such as crushers, grinding plates, and dies. It is also used in the mixtures for steam- and gas-engine cylinder blocks, valves, and other high-grade castings. The use of a percentage of charcoal pig iron in the mixture for such castings provides a tougher, stronger, and denser product, free from cracks, checks, breaks, and blowholes.

According to the Superior Charcoal Iron Co., Grand Rapids, Mich., charcoal iron has 30 per cent greater tensile strength and 25 per cent greater transverse strength than ordinary pig iron. This company recommends a 20 per cent charcoal iron addition to a foundry mixture as an important factor in the reduction of foundry scrap and defective castings.

The engineering department of the University of Michigan conducted research work at a large automobile plant, and in the course of this work found that charcoal iron reduced the small leaks, cold shuts, misruns, and other defects in automobile cylinder blocks from 30.6 per cent to 12.9 per cent in two months.

Briefly, the benefits claimed for charcoal pig iron, when used in a mixture with other pig iron, are reduction in shrinkage, increased strength, improved machineability, better wearing qualities, and higher finish on machined surfaces.

Advances in the Making of Malleable Castings

Present practice appears to restrict malleable-iron castings to lengths not exceeding 15 feet, and to sections less than 4 inches in thickness. Castings weighing but a fraction of a pound can, however, be made from the same heat as is used for the larger sizes. Besides strength, malleable-iron castings have the advantage of smooth, even surfaces and sharp outlines.

In a series of about 20,000 tests reported by seventeen investigators, the average tensile strength of malleable-iron castings was found to be 54,000 pounds per square inch, the yield point 36,000 pounds per square inch, and the elongation in 2 inches 18 per cent.

The American Society for Testing Materials specifies two grades of malleable castings. These specifications call for a tensile strength of 50,000 and 53,000 pounds per square inch, respectively, with a yield point of 32,500 and 35,000 pounds per square inch, and an elongation in 2 inches of 10 and 18 per cent. It will be seen that the results of the 20,000 tests referred to indicate that the average malleable-iron castings meet these specifications satisfactorily.

Ford Fender Die Made with Wearing Surface Inserts of Chrome-nickel Cast Iron

Non-Metallic Gear Materials

GEARS made from non-metallic materials of different kinds are being used to an ever increasing extent in industrial applications and in equipment used for a variety of purposes—from household appliances to heavy machinery drives.

H. M. Richardson, of the Plastics Department of the General Electric Co., calls attention to the fact that non-metallic gears have a remarkably high elasticity. The teeth of gears made from these materials will bend much more than metal gear teeth of the same proportions and under the same load, and the deflection of the gear tooth under load is large, as compared with the minute variations of tooth form and spacing. This allows the load to be shared by all the gear teeth engaged.

As an example, consider the case of a planetary speed reducer having a center pinion meshing with two or three planet or idler gears, and with an outside ring-gear enclosing the planet gears. If there is to be an equal division of load among the planet gears, they must be perfectly spaced, both as to angular location and center distance. In commercial production, however, there must be some manufacturing tolerances. These tolerances, even though very small, are quite large as compared with the deflection of metallic gear teeth. The non-metallic planet gears, however, have a high enough elasticity to allow the gears to divide the load almost equally.

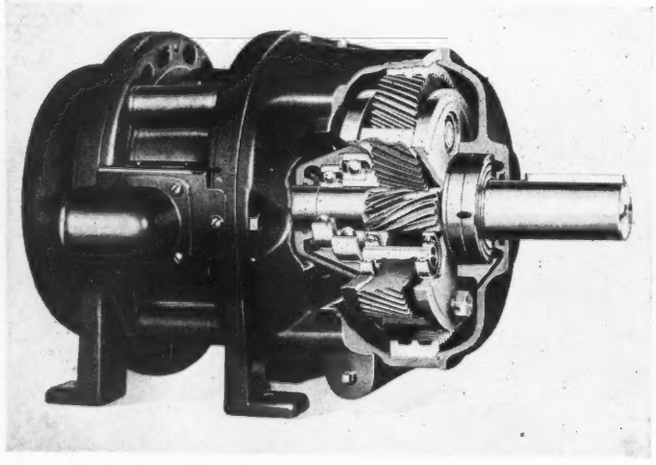
The high elasticity of non-metallic gears is also responsible in a large measure for their long life. One of the principal causes of gear-tooth wear is the high compressive stress at the points of contact between the rounded surfaces of the gear teeth in mesh. The high elasticity of non-metallic materials increases the area of contact on the tooth surface, thus greatly reducing the specific compressive stress for a given loading.

Another important cause of wear is the abrasion of the tooth surfaces. This may be reduced to a minimum by careful gear-cutting, insuring smooth surfaces, and by providing adequate means for lubrication and protection from abrasive materials.

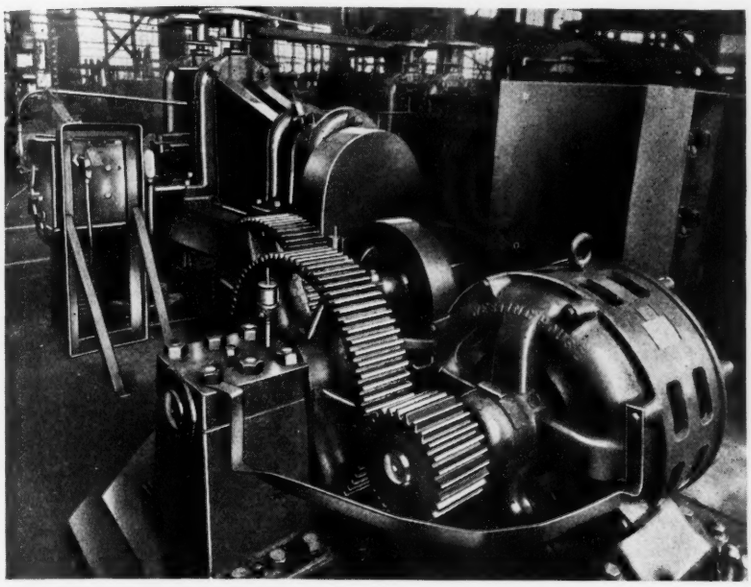
A third cause of gear-tooth wear is the cutting of the flank of the driving tooth by the tip of the entering driven tooth when the teeth come in contact. It is important to consider this factor in the design of non-metallic pinions when the non-metallic pinion is the driver and the metal gear the driven member. Here the high elasticity of the non-metallic material tends to work a disadvantage. This disadvantage, however, is rather easily surmounted, because the cutting of the driving tooth flank can be avoided by cutting the pinion with a long addendum and the gear that meshes with it with a short addendum. This combination has allowed successful designs to be made with much higher tooth loading and much longer life than could be expected from non-metallic gears cut to the traditional standard proportions.

There are numerous trade names applied to non-metallic materials suitable for gears. Textolite and Fabroil have been developed by the General Electric Co.; Micarta by the Westinghouse Electric & Mfg. Co.; Synthane by the Synthane Corporation; Celoron by the Continental-Diamond Fibre Co.; Formica by the Formica Insulation Co., etc.

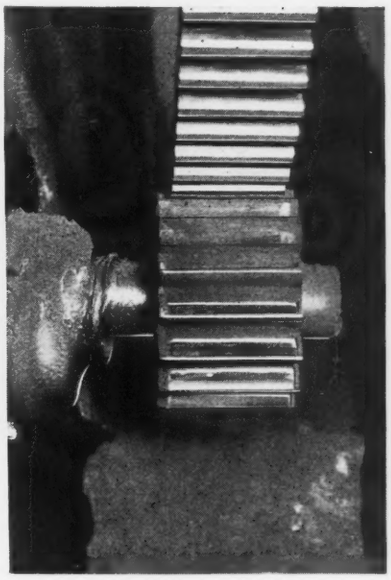
As an example of the physical characteristics obtainable in non-metallic materials, the properties of Synthane Laminated Bakelite gear materials may be quoted. These materials have a long fiber cotton, without sizing, as a base, and are unaffected by oils, moisture, and mild chemical solutions. The tensile strength of these materials is 10,000 pounds per square inch, with a transverse strength of 20,000 pounds per square inch. The compressive strength is 38,000 pounds per square inch. The Brinell hardness is from 36 to 40; the specific gravity 1.4, and the weight 0.05 pound per cubic inch, making 20 cubic inches to the pound; the coefficient of expansion is 0.00002 inch per inch per degree C.



A Single-reduction General Electric Gear-motor with the Gear Housing Cut away to Show the Construction. The Use of Textolite Planet Gears or Idler Pinions Permits Each Planet Gear to Take Its Share of the Load



A Westinghouse Micarta Driving Pinion for an Alligator Shear Transmitting a Large Amount of Power. In the Case of a Jam, the Micarta Pinion Serves as a Fuse, Protecting the Metal Gears in the Train



A Micarta Pinion Used for a Number of Years Where Coal Dust and Sulphur Water are Present

Among the non-metallic gear materials, rawhide occupies an important place. There was nothing accidental in the discovery that rawhide could be used advantageously in the manufacture of gears. As stated by the Chicago Rawhide Mfg. Co., while rawhide has always been synonymous with toughness and strength, previous to 1880 it was not used for gears. The advent of the electric motor in industry, the speeding up of machinery, and the need for a method whereby the noise of clashing metal gears could be reduced turned the thoughts of designers to rawhide. The first applications had in view the elimination of noise only; later it was found that vibration was also reduced. In operating with a metal gear, the non-metallic rawhide gear takes all the wear, and as a consequence, the larger mating gear never has to be replaced. This is a very important advantage of non-metallic gearing.

Magnesium Alloy—The Lightest Construction Metal

The extreme lightness of magnesium alloys has created a distinct place for these metals in the machinery industries. Because of their lightness, combined with strength and toughness, these alloys are particularly well adapted for use in the aircraft and automobile industries, as well as for portable hand-operated equipment and high-speed reciprocating parts. The more important applications in the airplane industry include crankcases, housings, covers, fuel tanks, ribs, struts, wheels, etc. The application in aircraft and automobile work was more rapid in Europe at first than in this country, but of late there has been a considerable increase in the use of these light alloys here.

Magnesium alloys are available in sheets, rolled sections, forgings, and castings. The following figures apply to alloys known as Dowmetal, made by the Dow Chemical Co., Midland, Mich.

Forged magnesium alloys have a tensile strength of from 37,000 to 48,000 pounds per square inch, according to the type of alloy used, and a compression strength of from 45,000 to 65,000 pounds per square inch. The Brinell hardness varies from 38 to 58. The cast alloys vary in tensile strength from 22,000 to 38,000 pounds per square inch, the lower figure being for castings not heat-treated, while the higher figure applies to heat-treated alloys. The compression strength ranges from 38,000 to 51,000 pounds per square inch. The Brinell hardness varies from 43 to 80.

Since the weight of magnesium alloys for an equal volume is only about one-fourth that of steel, it is evident that it is possible to obtain, in many instances, with magnesium alloys, a strength equal to or exceeding that of steel, using less weight.

Magnesium alloys are all easily machined. Both the speed and the depth of cut can be considerably increased, as compared with the usual shop practice for iron and steel. Light finishing cuts can be taken to obtain a smooth surface.

Free-Cutting Screw Stock

THE most outstanding advance made in screw stock within the last few years is the development of steels having greatly improved machining qualities. Previous to the development of these new materials, practically the only steel commonly referred to as "screw stock" was low-carbon steel having approximately the following composition: Carbon, 0.08 to 0.20 per cent; manganese, 0.30 to 0.80 per cent; phosphorus, not over 0.12 per cent; sulphur, 0.06 to 0.12 per cent. The S A E screw-stock steels 1112, made by the Bessemer process, and 1120, made by the open-hearth process, come approximately within this composition range.

The screw stock produced by the Union Drawn Steel Co., Massillon, Ohio, under the trade name "Supercut," is a typical example of what has been accomplished in the improvement of machineability by introducing a higher sulphur content. In applications where S A E 1112 screw stock cannot be cut at speeds greater than approximately 150 surface feet per minute, this new screw stock can be cut at approximately 250 surface feet per minute. As this screw stock also permits faster feeds, the average increase in output, in using the latter material, is estimated to average approximately 75 per cent. Even at these high speeds, a smooth finish is produced that is somewhat superior to that obtained with S A E 1112. The physical properties of the material also compare favorably with S A E 1112.

Recent developments in the manufacturing methods used by the Jones & Laughlin Steel Corporation, Pittsburgh, Pa., for producing Bessemer screw stock have greatly improved the machineability of this class of steel. Marked increases in the production rates of machines operating on the improved steel have been recorded, solely as the result of better machineability of the stock. It is also possible to maintain the cutting edges on the tools for a longer time than previously.

A stainless steel that can be machined in automatic screw machines with standard tools and speeds equal to or closely approximating those used for common Bessemer screw stock has been placed on the market by the Carpenter Steel Co., Reading, Pa. This free-cutting Carpenter stainless steel—No. 5—contains 0.10 per cent carbon, 14 per cent chromium, and 0.30 per cent sulphur. This material can be easily drilled, tapped, and threaded with dies. The addition of sulphur in this steel overcomes the difficulty previously experienced in machining stainless steel. Recently, a still further improvement in free-cutting stainless steel was made by substituting selenium in place of sulphur to obtain the free-cutting properties desired.

Fiber in Machine Construction

HARD vulcanized fiber is employed for many purposes in the machinery industries. When used to replace metal, in the applications for which it is suited, it combines the advantages of increased efficiency and lower cost. As examples of its use may be mentioned bearings or bushings for low-speed shafts—for example, cloth roller bearings on textile machines; bobbins; and the wearing surfaces of shuttles, where it is of value because of the density and toughness of the material. It resists abrasion and will withstand constant use and abuse without chipping, splintering, or breaking.

Many fiber parts are used in electric clocks, not only because of their good insulating qualities, but also because of the wearing properties of this material. A special grade of hard vulcanized fiber has been developed for vacuum cleaner parts. In this application it has proved superior to metal. It has revolutionized practically the entire assembly of these vacuum cleaners, where light weight and long wear are important qualities. Further advantages of this material are that it will not dent and its color is permanent.

Spauldite, a laminated phenolic product of the Spaulding Fibre Co., Inc., Tonawanda, N. Y., is used in place of metal for pulleys in airplanes. It is also used for thrust washers in automobile water pumps and appliances operating under similar conditions. In rotary pneumatic tools, metal valves have been replaced by this material, as it does away with the friction resulting from metal-to-metal contact.

Hard vulcanized fiber is particularly suitable for different types of rollers, replacing either metal or wood—as, for example, in conveyor rollers and rollers for garage doors. Here the fact that fiber cannot corrode and that it provides quiet operation and long wear is especially important. In filing cabinets, fiber rollers are largely used for the same reasons. This material will be increasingly used in the industrial field as its many applications are more fully understood by machine designers.

Vibration-Absorbing Materials

Rubber and Cork are Being Increasingly Used in the Construction and Mounting of Machine Equipment

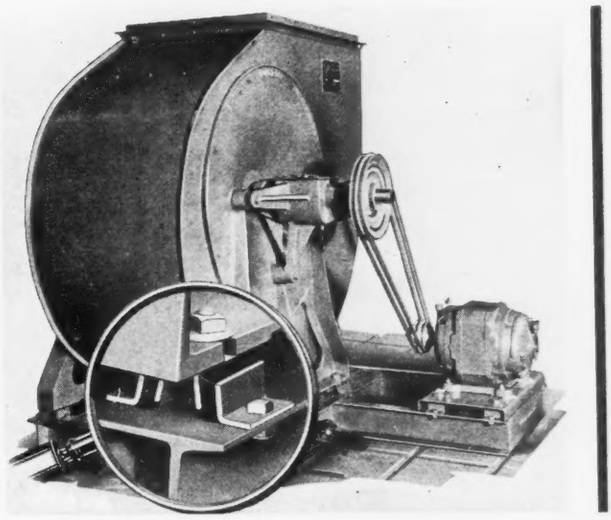
WHEN we think of rubber, we are likely to think of automobile tires, and, of course, the greatest amount of rubber used goes into tires. Because of this use, rubber has achieved the distinction of being one of the more important materials used by industry, although it is only recently that it has found a thoroughly practical application in machine design. Of late, however, many uses have been found for this material as an integral part of machine assemblies, and it is now applied for many purposes in machine design, especially where vibration-absorbing mountings are needed.

Mountings to absorb vibration are now widely used, covering a range from delicate aviation instruments to automobiles. Shock- and vibration-absorbing mountings are made in the form of both tubular and flat members. Tubular members are constructed of an outer steel bushing and an inner bushing, or solid pin, with rubber filling the space between the two members. The rubber is vulcanized directly to the metal parts so that it is integral with them.

The mountings may also be made from two flat plates with rubber between them, vulcanized directly to the plates. Such mountings are now made in designs small enough for a radio tube and big enough for large Diesel-electric units. Most automobile manufacturers now use rubber mountings for supporting the engines, and also for spring-shackle joints, radiator and muffler supports, as well as for body supports.

A 5000-pound industrial blower, cushioned by eight half-inch strips of rubber, operates silently, with hardly any noticeable vibration. But the strips of rubber are not merely laid flat as supports under the blower. As made by the Firestone Tire & Rubber Co., Akron, Ohio, they are bonded, in the manner indicated in the illustration, to strips of brass-plated steel. The rubber-metal cushion unit is bolted to the machine and to the floor, leaving the rubber strips in shear between the two plates.

The rubber cushions are so curved as to offer progressively greater resistance to loads and shocks as the compression stresses increase. Vibrations from the machine are absorbed and dissipated as the rubber yields under the vibrations, thus eliminating noise, as well as protecting the machine. The life of the equipment is obviously lengthened through the reduction of wear caused by vibration and, at the same time, the mechanical efficiency is increased.

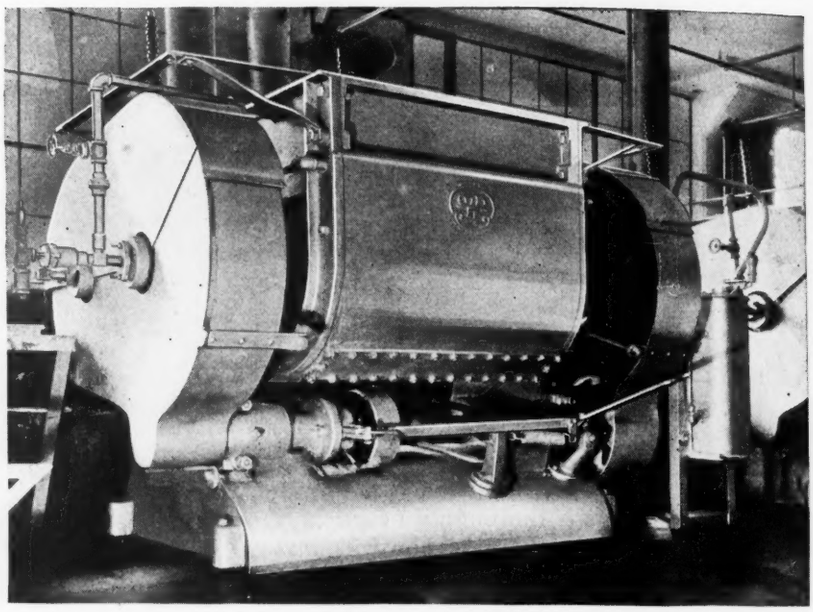


Blower Mounted on Firestone Vibration Dampener. Enlarged Insert Shows the Construction of Bonded Steel and Rubber Cushion Strips

During recent years cork has been applied to an ever increasing extent as a foundation for motors, engines, fans, blowers, pumps, printing presses, generators, elevator machinery, etc. The cork foundation makes it possible to operate equipment of this kind quietly and with freedom from vibration. Even whole floors of buildings can be effectively isolated by cork foundations.

One of these cork products, known as "Vibracork," has been developed by the Armstrong Cork & Insulation Co., Lancaster, Pa. This material consists of pure cork compressed into boards of uniform quality and density. The material does not deteriorate or disintegrate, and hence will last for years. The broad application of these cork foundations may be best indicated by referring to a number of actual installations.

In a plant making storage batteries, a 60-horsepower Diesel-generator unit placed on a concrete base caused vibrations that could be felt a block away from the plant. Numerous complaints from neighbors indicated the necessity of applying corrective measures. Therefore, when a 120-horsepower unit had to be installed to take care of increased plant requirements, it was decided to isolate



Three-ton Mixing Kettle Weighing 6000 Lbs., Driven by Self-contained Motor. Effective Isolation is Obtained by a 2-inch Layer of Armstrong Vibracork

the engine foundation with cork. The result was astounding. The vibrations from the 120-horsepower unit could not be noticed outside the building.

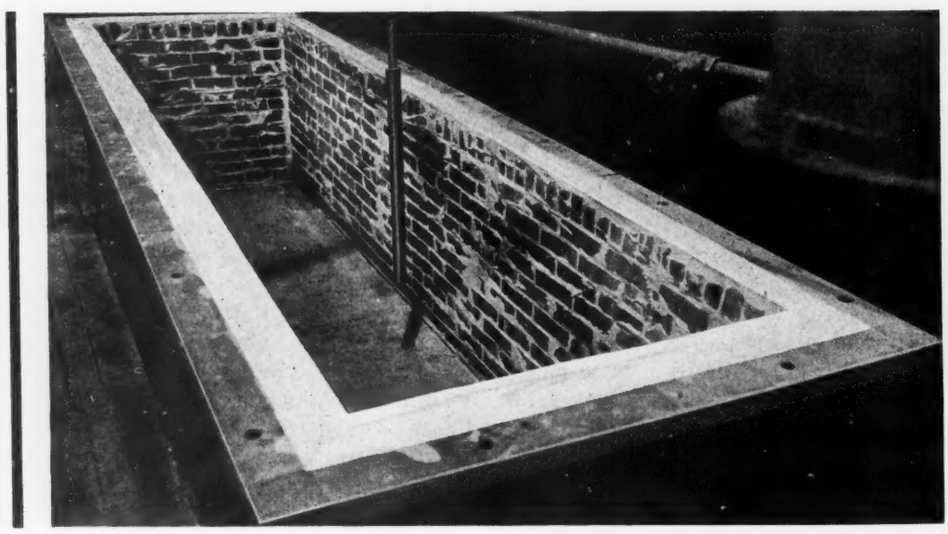
In the Hotel New Yorker in New York City, the complete ventilating and air-conditioning plant, including pumps, fans, and motors, is operated noiselessly by the use of cork foundations for all rotating apparatus. In the Commodore-Perry Hotel in Toledo, four compressors, eighteen pumps, and twenty-one motor-driven ventilating fans are similarly supported on cork foundations, with practically all noise and vibration eliminated.

Vibrations caused by printing presses and other printing plant equipment have been overcome by placing the machines on cork foundations. So effective is this isolation, that vibration is imperceptible outside the press room.

An improvement in the construction of tanks for the pickling of steel is now available. The B. F. Goodrich Rubber Co., Akron, Ohio, has developed a new form of rubber lining, known as "Triflex," designed especially to meet the severe conditions encountered in cleaning steel with acids. Triflex consists of a layer of hard rubber cushioned between two plies of resilient soft rubber. The three plies are vulcanized together to form an integral lining structure which is bonded to a steel tank with an adhesion exceeding 500 pounds per square inch. The process of lining welded steel tanks in this manner is known as the "Vulcalock" process and is believed to afford a degree of strength and permanence hitherto unattainable.

While these linings are most extensively used for tanks, they can also be applied effectively to pipes, valves, fittings, drums, pumps, and similar parts.

Perhaps the outstanding feature of this application is that very high temperatures can be used if a heat-insulating material such as brick is applied next to the rubber. Tanks lined with three-ply rubber and brick sheathing have been used for handling highly corrosive materials at temperatures up to 250 degrees F.



This Steel Pickling Tank, Lined with Goodrich Triflex Rubber Lining and a Brick Sheathing, Makes it Possible to Handle Sulphuric Acid at a Temperature of 250 Degrees F.

Die-Casting Metals Set New Standards

Improvements in Metals no Less Than in Methods Have Made Present Advances in Die-Castings Possible

DIE-CASTING metals have been developed within recent years that make it possible to produce parts by die-casting that no one would have expected to make by this process a few years ago. Both zinc-base and aluminum die-castings are now made in much larger sizes than formerly. It is possible to hold them to closer accuracy and to obtain greatly improved strength, wear, and durability; and brass die-castings are no longer experimental, but a regular commercial product.

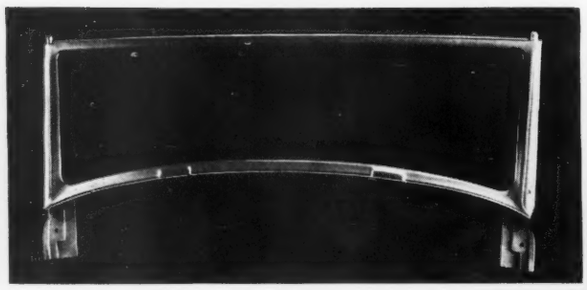
Aluminum die-castings weighing up to 18 pounds, with over-all dimensions approximately 34 by 12 by 6 inches, are being produced commercially. By decreasing the width and height, the length can be increased so that die-castings up to 40 inches long can be produced; and a length of 25 inches is quite common. On these large die-castings it is possible to maintain a section thickness as small as 0.090 inch; and on castings less than 6 inches in length or width, a thickness as small as 0.040 inch can be maintained.

The new zinc alloys that have recently been made available in the die-casting field permit stronger and denser castings to be made, with surfaces of finer finish, than was formerly possible. The most important improvement in the new alloys, however, is their permanence of physical properties and dimensions.

Die-castings are now being used in almost every industrial field. The automotive industry was one of the first to make extensive use of these castings, and that industry is finding ever increasing applications for them. But other industries are also using die-castings to a great extent. Not less than seventy-five per cent of the parts in a recently designed electric hoist are made from zinc die-castings; in a bench lathe, forty-three die-castings are used; and the rotor of a squirrel-cage induction

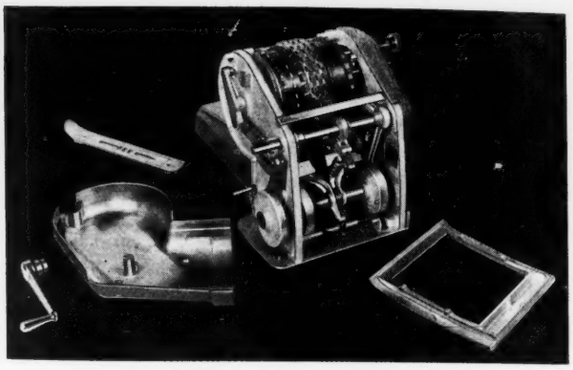
These Die-castings are the Heavy Transmission Parts for the New Lamson Conveyor. The Entire Assembly Weighs Nearly 70 Pounds, while the Large Car in Back Alone Weighs 29 Pounds

Courtesy Precision Castings Co., Inc.



The Windshield Frame and Cowl Bar of the Cadillac "Convertible" is an Excellent Example of a Large Chromium-plated Zinc Die-casting —Courtesy New Jersey Zinc Co.

The Entire Assembly of the "Initialator" is Made up Almost Completely of Zinc Die-castings — Courtesy New Jersey Zinc Co.



motor is another most interesting application. The rigidity and strength of die-castings is indicated by the fact that they are used for washing machine frames, windshield frames, and similar requirements. Their impact strength is attested by the fact that die-castings are now used for golf-club heads.

Die-castings of zinc alloys can be held to a predetermined hardness by a process that has recently been developed. For example, it is said to be possible to make a spindle by the die-casting process from a zinc alloy so that each casting produced will record almost exactly a Rockwell hardness of, say, 93, this being tested with a 1/8-inch diameter ball and a 100-kilogram load.

Additional possibilities for die-castings have been opened up through developments in plating and cleaning methods. Zinc die-castings, for example, can be plated with no more difficulty than parts of other generally used metals. The process and the solutions used are somewhat different from those employed for plating brass and steel, but the process is no more costly. Laboratory investigations, amplified by careful records of commercial experience, have resulted in the formulation of a plating procedure by which it is possible to produce dense adherent coatings comparable with those obtained on brass and steel.

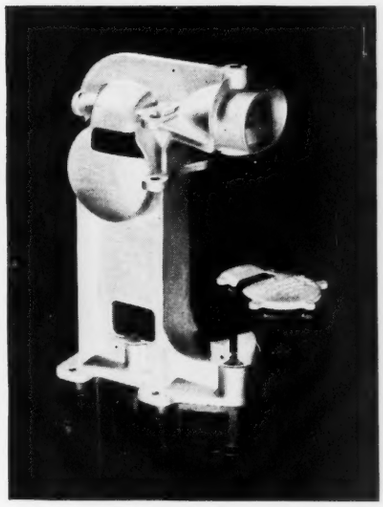
Aluminum-alloy die-castings can be finished by a great number of different methods. They can be sand-blasted, painted and lacquered, or scratch-brushed. They can also be finished by bright-dipping, ball-burnishing, polishing, plating, and oxidizing.

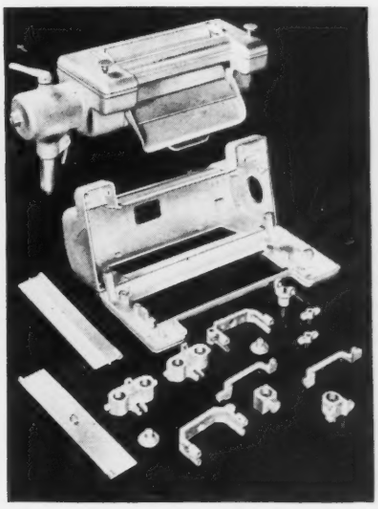
Nickel is being used to some extent in both aluminum- and zinc-base die-castings, many of which contain from 0.5 to 5 per cent nickel. Aluminum alloys for pistons and cylinder heads of internal-combustion engines and crankcases are frequently made with a nickel content of approximately 2 per cent.

The majority of the aluminum alloys used for die-castings are aluminum-copper alloys, aluminum-silicon alloys, and aluminum-copper-silicon alloys. Aluminum-copper alloys are more easily machined and have a brighter color than the other aluminum alloys, whereas the aluminum-silicon alloys are easy to cast and are highly corrosion-resistant. The aluminum-copper-silicon alloys have been developed with a view to obtaining the advantages of both the copper and silicon alloys.

The aluminum-alloy die-castings produced for commercial purposes are generally made within limits of accuracy of plus or minus 0.0015 inch per inch. The tensile strength of the aluminum alloys used for die-castings is about 30,000 pounds per

Brass is Now being Used as a Material for Die-castings. Note Use of Steel Inserts in Die-cast Parts — Courtesy Doehler Die Casting Co.





(Left) Die-cast Aluminum Base and Cover Plate for an Automatic Canning Machine. (Right) Automatic Washing Machine Wringer Made from Aluminum Die-castings—Courtesy Aluminum Co. of America

square inch; for some of the alloys, this figure is even higher.

The two illustrations at the top of the next page show aluminum die-castings that are remarkable examples of the possibilities of die-cast metals. The illustration at the left is a base and cover plate for an automatic canning machine; that to the right, an automatic washing machine wringer and the parts used in its construction. Light weight, combined with the required strength, is assured by the use of die-castings for these parts.

The development of copper-base die-castings is a distinct step forward in the die-casting art. The Doehler Die Casting Co. has developed the art of brass die-castings to a point where these castings can be used successfully for a wide variety of purposes. They have all the advantages of die-castings of other types—sharpness of detail, the possibility of using steel inserts, thin walls, the possibility of casting holes, accuracy, etc., and, in addition, a strength equal to that of steel.

According to C. I. Hodgson, vice-president and plant manager of the Doehler Die Casting Co., brass die-castings can be made with a tensile strength of from 65,000 to 75,000 pounds per square inch, a yield point of from 35,000 to 40,000 pounds per square inch, and an elastic limit of from 20,000 to 30,000 pounds per square inch. The elongation is from 15 to 20 per cent in 2 inches, and the Brinell hardness from 130 to 140. Die-castings can also be made from a white nickel brass when a white color is desired.

A copper-base alloy known as "Brastil" has been developed which has the color of white gold, with high strength and hardness, good bearing qualities, and high resistance to corrosion, fatigue, and shock. This alloy, as made by the Doehler company, has a copper content of 81 per cent and a tensile strength in die-castings of from 90,000 to 95,000 pounds per square inch. The elongation is from 10 to 17 per cent in 2 inches, and the Brinell hardness is from 160 to 180. Parts ordinarily made from steel, because of the strength required, can be cast from this alloy.

Machine designers are beginning to appreciate the possibilities of the die-casting process and are making use of die-castings more and more. Without question, these castings will continue to occupy an increasingly important place in the mechanical industries. The economy of die-castings made in large quantities and to closely held dimensions is obvious. Recent developments indicate that similar economies can be obtained when comparatively small quantities are to be made. The development of the methods by which die-castings are made and the materials from which they are produced have advanced together, to make possible the present quality and characteristics of die-castings.

A Collection of Slides, Gears, Cams, and Other Commonly Used Machine Parts that are Die-cast from Brass by the Doehler Die Casting Co.

Copper Alloys that Have the Strength of Steel

Copper and Copper Alloys are Finding a Constantly Increasing Number of Applications in Industry

Tobin Bronze Repair Welding of a Fractured Cast-iron Machine Part —Courtesy American Brass Co.

THE corrosion-resisting properties of copper and its alloys have been a boon to mankind since the days of ancient Egypt, when copper piping was probably first used for conveying water. That the Egyptians fully appreciated the lasting qualities of copper is evidenced by the fact that their symbol for "enduring life"—a circle with a cross attached—was also the symbol for copper.

Today copper alloys are employed for countless purposes other than for resisting rust; however, the use of copper for parts exposed to water and acids is of vast importance.

One handicap to the even wider use of copper alloys has been their lower strength in comparison with some of the other common metals. For years metallurgists tried to find some element that would alloy with copper and give it a strength approaching that of steel. This objective was reached some years ago with the development of a silicon bronze wire that has been successfully used in telegraphy. Not until the last few years, however, have silicon bronze alloys been available to general industry.

Now silicon bronzes with tensile strengths as high as 120,000 pounds per square inch are obtainable in the form of hot-rolled, cold-rolled, or cold-rolled and annealed sheets, plates, and strips; hot-rolled or cold-drawn rods, bars, and shafting; die-pressed or hammered forgings; rivets; welding rods; and ingots for sand castings. In addition to being corrosion resistant and of unusual strength, silicon bronzes are non-magnetic, remarkably ductile, readily worked, and easily welded. Silicon bronzes are known by many trade names such as Everdur, Herculoy, Duronze, Olympic, etc.

These new bronze alloys have the strength to withstand the high stresses produced by temperature changes, wind pressure, etc. In rods, bars, and shafts, the tensile strength ranges from about 55,000 to 120,000 pounds per square inch. These materials are suitable for making bolts, nuts, machine screws, boat-propeller shafts, pump piston-rods, and many other parts too numerous to mention. Gears, pinions, and worms can be cut from hot-forged blanks.

Sheets of silicon bronze have a tensile strength ranging from about 55,000 to 90,000 pounds per square inch. These sheets may be fabricated into high-pressure tanks, pickling tanks and baskets, marine hardware, household range boilers, etc. The sheets can be readily stamped and deep-drawn into many parts. Silicon bronze can be welded by both the oxy-acetylene and electric arc methods.

The tensile strength of silicon bronze castings is about 53,000 pounds per square inch. This alloy pours freely and does not shrink more than brass or other bronzes. Gate valves represent a typical example of castings made from this material.

Another recent development in the field of copper alloys is beryllium copper, a material with a high tensile strength that can be greatly increased by heat-treatment. For example, the tensile strength of a piece of hard drawn beryllium copper wire was 108,000 pounds per square inch. This strength was increased through heat-treatment to 190,000 pounds per square inch. Standard beryllium copper consists of 2.25 per cent beryllium and the remainder pure copper. It is available in sheets, strips, wire, and rod. Castings have also been produced from this alloy in certain cases with entire success.

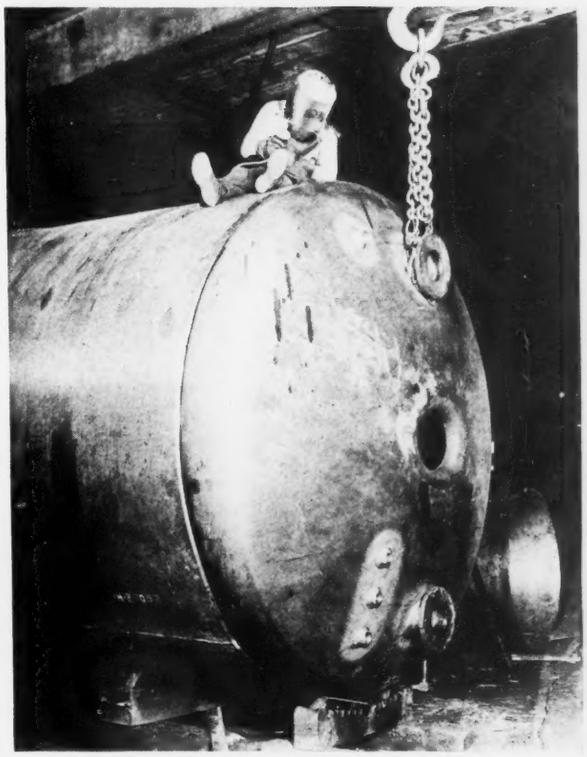
In addition to high tensile strength, beryllium copper has a high fatigue limit and hardness. Various hardness values can be obtained, making it pos-

sible for this alloy to meet requirements previously considered beyond the scope of non-ferrous metals.

Beryllium copper is suitable for a large variety of parts. Wrenches, chisels, hammers, screwdrivers, and other hand tools can be made from it for use in hazardous places where a spark from steel tools might cause an explosion and fire. Thus, the metal should find wide use in the petroleum and chemical industries; paint and lacquer works; automobile body plants; grain elevators, etc. Balls can be made from this alloy for use in pulverizing mills. Bearings and other parts that must withstand a severe rubbing action are other typical applications.

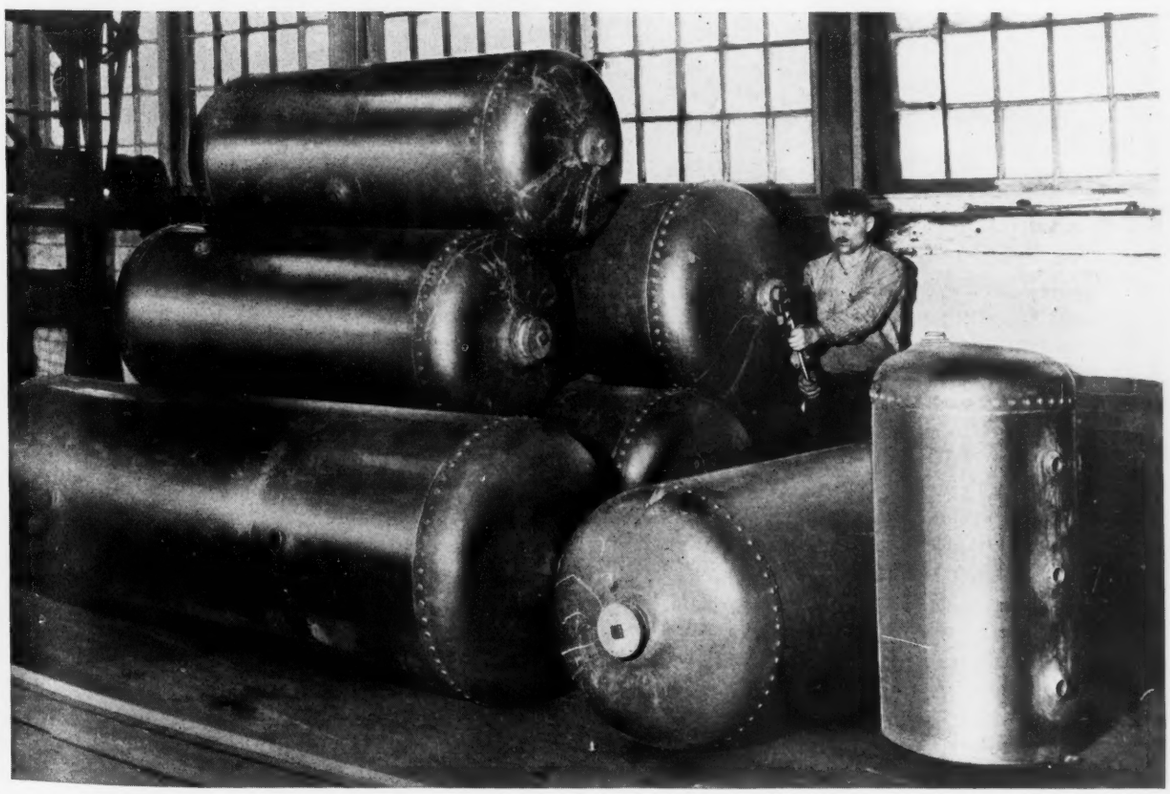
Beryllium copper is suitable for the contact tips of plugs on all sorts of electrical appliances. Another interesting application is the use of this alloy as a snap spring between the relay contacts of electrical switches. In one switch, where springs of a standard bronze lasted from 500,000 to 1,200,000 operations, a spring of beryllium copper of the same gage was used 11,000,000 times without failing.

Sleeves cast from beryllium copper are used in airplane adjustable-pitch propellers to serve as bearings for the driving shaft and the propeller hub. The material is hard enough to take all loads on these parts without scuffing or sticking.



(Above) One of Two 10,000-gallon Welded Everdur Storage Heaters Fabricated by Whitlock Coil Pipe Co. for 85 Pounds Pressure and 200 Degrees F. Water Temperature—Courtesy American Brass Co.

(Below) Herculoy Alloy is Used for High-pressure Hot-water Storage Tanks, as well as for Tanks Used in Chemical and Other Industries—Courtesy Revere Copper & Brass, Inc.



Tungsten Carbide Prolongs the Life of Machine Parts

The New Alloy is Useful Not Only for Cutting Tools but as a Metal to Resist Wear

TUNGSTEN carbide is remarkable for two characteristics—first for its hardness, which is next to that of the diamond, and second, for its compressive strength, which is greater than that of any other known material. The advantages of tungsten carbide as a metal-cutting material are well known, but it is not so generally understood that this alloy is also an ideal material for use in cases where machine parts are subjected to excessive wear. A number of examples referred to by E. C. Howell, of the Carboloy Company, Inc., show the wide application of tungsten carbide as a wear-resistant material.

In a plant manufacturing lock-washers, the steel guide blocks formerly used in certain machines were subjected to such abrasion that they lasted from nine to eighteen hours only. It required about forty-five minutes to replace them. These blocks cost $2.50 each. Tungsten-carbide blocks were installed some time ago, and at the last report, they had lasted 250 hours without appreciable wear. The savings during this period amounted to $41.70, after allowing for the higher cost of the tungsten-carbide blocks.

In the same plant, a battery of twelve automatic machines which shape and cut lock-washers have been supplied with tungsten-carbide guides at a saving of $397 in three months. The washers are made of cold-drawn steel with a Rockwell C hardness of about 90.

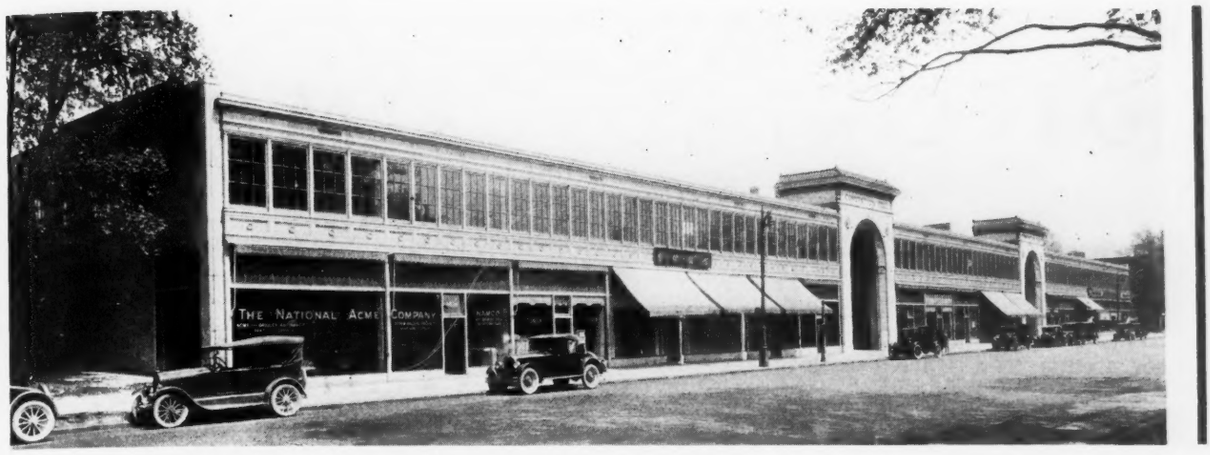
In another plant having a large number of hydraulic presses, ranging in capacity from 25 to 2000 tons, four men were formerly kept busy replacing worn stems and seats. Since this concern adopted the practice of tipping the stems and seats with tungsten carbide, the part-time service of one man only is required for this work.

Tungsten carbide has also been used for nozzles that deliver abrasive materials. In another case, a manufacturer of coated welding rod found it difficult to coat the wire uniformly until he provided a tungsten-carbide insert in the coating die. In coating 5/32-inch wire, high-speed steel dies showed an average wear of 0.001 inch in hole diameter for every 1500 feet of welding rod. With an insert of tungsten carbide in the die, 180,000 feet of wire can be coated for each 0.001 inch increase in the size of the die hole. The use of tungsten-carbide inserts has resulted in lower die costs, less maintenance expense, and a more uniform product.

Tungsten-carbide Inserts Increase Life of Centerless Grinder Blades Six Times

The work-blades of centerless grinders are subject to such severe wear in many operations that frequent redressing is necessary. In order to reduce maintenance costs in a gear-manufacturing plant, it was decided to provide the work-blades of the centerless grinding machines with tungsten-carbide inserts. As a result, 10,000 pieces per grind of the blades are now obtained regularly, as compared with 1600 pieces formerly. In one instance, 574,000 pieces were obtained per grind of the tungsten-carbide blades, as compared with less than 2000 with blades made from other materials.

Inserts or tips of tungsten carbide are being used for the contact surfaces of many types of gages, indicating instruments, and micrometers, to insure accuracy for a long time. Tungsten carbide has also been employed successfully on burnishing tools, lathe and grinder centers, master cams, and other parts that must withstand a constant wearing action.



The Metal Congress and Exposition

DETROIT'S famous Convention Hall will be the scene of this year's National Metal Exposition, to be held during the week beginning October 2. This show promises to be the largest metal exposition since 1929. The exhibits occupy 50 per cent more space than last year's show at Buffalo. New developments in materials and heat-treating equipment will be seen on every side, while equally important exhibits of standard products which have already reached a high level of perfection will be on view. Arrangements have also been made with some twenty Detroit plants to permit visitors to the Congress to inspect some of their most interesting departments and processes.

In conjunction with the exposition, the American Society for Steel Treating, cooperating with a number of the national engineering societies, will hold its annual convention. At the steel treaters' meetings alone, thirty technical papers will be presented, recording the achievements in metallurgy.

The Institute of Metals and the Iron and Steel Divisions of the American Institute of Mining and Metallurgical Engineers will hold four technical sessions, at which fourteen papers will be presented. The American Welding Society has scheduled twenty-nine papers for its seven sessions.

The American Society of Mechanical Engineers, under the auspices of the Machine Shop Practice Division, will hold a session at the Hotel Statler at which two papers will be presented. One paper, entitled "Characteristics and Methods of Tests of Automotive Brake-drums," will be read by C. L. Eksergian, chief engineer of the Budd Wheel Co., and the other, "Simplicity, the Solution of Extreme Accuracy in Quantity Production," will be presented by Gordon M. Evans, vice-president in charge of manufacturing of the Kelvinator Corporation. A. N. Goddard of Goddard & Goddard will act as chairman of the Machine Shop Practice Division session.

EDITORIAL COMMENT

A manufacturer writes us: "Many codes are being written with a clause stating that new machines will not be installed to increase production. I am told that one code states that production machinery will be used sixteen hours a week only.

Industry Must Combat Wrong Ideas on Cause of Unemployment

"I have seen one code—in the foundry business—that says: 'We will not buy any kind of machinery that will increase production unless all other foundries have the same machinery, nor will we use any new system to increase production unless every foundry uses the same system.' This, of course, is socialism. If such an idea is carried out, it means that no shop will try to make any improvements."

Whether this is socialism, as our correspondent suggests, or something else, it *is* a denial of progress—sheer folly of the most dangerous kind. It not only has no basis in reason or common sense, but would result in serious damage to the very cause we are trying to help.

There is a vast difference between bold measures and those that are the result of haste and hysteria. It is time for bold thinking and careful planning; but before attempting to prescribe a remedy, we must diagnose the malady. We must find out *where* the fault is and *what* it is.

Contrary to the superficial findings of pseudo-economists, the fault in our economic system does *not* lie with manufacturing efficiency and production equipment. High production has been blamed for our difficulties not only by politicians and labor leaders, but even by some manufacturers, who do not fully appreciate the distinction between "efficiency in production" and "over-production." It is no more necessary to over-produce, because of efficiency, than it is possible to prevent over-production by inefficiency. We had "hard times" long before we had production machinery.

A High Standard of Living is Based on High Production

The depression and the unemployment from which our nation has so severely suffered during the last three years is not the result of machine production. It is the result of faulty financial and economic methods which, together, brought about a faulty distribution of buying power, so that the individual's ability to consume the products of industry was severely restricted.

The remedy is not to be found in forcing industry to take a backward step toward the days of inefficient manufacturing methods, but by adjusting our financial and economic practice so that it will keep pace with the advance in engineering.

It is obvious that this country cannot consume more—and thereby enjoy a higher standard of living than the rest of the world—unless we produce more. We can consume only that which we have produced. Consequently, to lower our manufacturing efficiency is to lower our standard of living. To look for a cure through such measures is like telling a starving man to go on a more restricted diet! It is only by a combination of increased manufacturing efficiency and *equitable distribution* of the products of industry and agriculture that a higher standard of living can be achieved.

Permanently higher wages can only be paid if more wealth in the form of goods can be produced and put to use by a constantly larger number of people; and this greater production can be achieved only through greater manufacturing efficiency. These two factors—production and wages—are inseparably linked together to make higher consuming ability possible.

Efficient Labor and Machinery Make High Wages Possible

Destroy efficiency by making use of out-of-date and unsuitable machinery, and wages and consuming power will ultimately go down with it. Keep up the efficiency of equipment and manufacturing methods, and we will have an opportunity to correct the mistakes in distribution that have been the main source of our economic difficulties.

Many have interpreted the statements of the President and of the Director of the National Industrial Recovery Act to mean that the use of production machinery should be curtailed, and that improved equipment should not be acquired, even when it can be advantageously employed to reduce cost, prevent waste, and improve living conditions. This being the case, it would be well if the President or General Johnson would come forth with a definite statement to the effect that the Administration does not discourage the use of production machinery—the cornerstone on which the high standard of living in this country has been built.

The Code of the Machine Tool Industry

The Machine Tool Builders' Association's Code Contains Several Sections that May Well be Adopted by Other Metal-Working Industries

THE Code of Fair Competition for the Machine Tool Industry, submitted by the National Machine Tool Builders' Association, contains, in addition to the usual regulations pertaining to hours and wages, several clauses relating to employment, the gathering and distribution of statistical information, and unfair practices that differ in some essentials from those adopted by other industries and that, therefore, are of particular interest.

The section pertaining to unfair practices is brief and to the point. It does not pretend to enumerate all possible unfair practices, because it is obviously believed by the framers of the Code that what is unfair practice is well understood. Hence, the subject is dealt with simply as follows:

"Unfair practices shall be deemed to be practices or acts which, by subterfuge, concealment, misrepresentation, or by any form of discrimination, result in selling below published prices, or in deceiving or misleading purchasers, or in misrepresenting the products of competitors. Any such unfair practice is hereby declared to be and to constitute an unfair method of competition."

Labor Relations and Employment

On the subject of employment and labor relations, the Code, in addition to reiterating the provisions which are called for by the National Industrial Recovery Act, has this to say:

"Nothing in this Code shall prevent the selection, retention, or advancement of employes on the basis of their individual merit, without regard to their affiliation or non-affiliation with any labor organization or with any other lawful organization.

"Nothing in this Code shall prevent any individual employe from bargaining individually with his employer, if both so desire.

"The Industry has recognized the right of the employes of any employer to bargain collectively with such employer, through representatives chosen by such employes from among themselves, without interference, coercion, or restraint from their employer or from anyone.

"These principles, long recognized and practiced in the Industry are, in the judgment of employers, in the interest of the employes, and in the opinion of the employers should be maintained and protected."

Provisions for Complete Statistics of the Industry

A complete and detailed system of statistics is provided for. The National Machine Tool Builders have collected such statistics for many years, but all members have not contributed data. Under the Code, the statistics will be more comprehensive than ever before, and will also cover a wider range of subjects. The section pertaining to the classes of statistics to be compiled reads as follows:

"The members of the National Machine Tool Builders' Association and the subscribers to this Code agree to contribute to the Association office figures covering their company's experience, for compilation of industry reports on the following items:

"1. Monthly reports on total volume of new orders, in dollars, classified according to foreign and domestic destinations.

"2. Monthly detail reports, classified by types and sizes of machines agreed upon by members of each group, covering unfilled orders, new orders, cancellations, shipments, and stocks on hand, in units.

"3. Monthly reports on wages paid, by classes of labor.

"4. Monthly reports of average hours of employment, by classes of labor.

"One copy of each such composite industry report, when compiled, shall be made available to each member of the industry without charge."

Except for copies of the composite industry report, these statistics shall be confidential. The Code provides: "Except as otherwise provided in the Act, all statistics, data, and information filed in accordance with the provisions of the Code shall be confidential.

"The statistics, data, and information of one employer shall not be revealed to any other employer, except, that, for the purpose of administering or enforcing the provisions of this Code, the Supervisory Agency, by its duly authorized representatives (who shall not be in the employ of any employer affected by this Code), shall have access to any and all statistics, data, and information that may be furnished in accordance with the provisions of this Code."

The Code is simple and comprehensive. Most of the provisions have been adhered to by the industry in the past, since the machine tool industry is one of the few machinery industries that has long been highly organized in an effective trade association. The Code, however, will give uniformity and authority to all these practices, and will place the industry in a position to serve all concerned—employers, employes, and customers—in an equitable manner.

Does Production Machinery Throw Men Out of Work?

By PETER HALL
President
The Hall Planetary Co.,
Philadelphia, Pa.

EVER since machinery began to be used to replace hand labor, most people have believed that machines threw men and women out of work. In many cases, workers have destroyed machines, believing that they would be ruined by the use of any kind of machinery. This fight against machinery has been going on for about two or three hundred years. Today the greater part of the population of this country really believes that modern production machines throw men out of work.

In view of this, it is curious to reflect upon the fact that the Russian Government at this time, being run by the workers themselves, is buying all of the most modern high-production machines that the nation can afford to acquire, in the firm belief that machinery will free the worker from drudgery and create prosperity and well-being for all.

The United States has the highest standard of living of any country in the world. Why? Because of the production machine. The best proof of this is the automobile industry in the United States. Up to the time of the recent depression, this industry was constantly growing, and constantly employing more people, and at the same time, made more use of improved production machinery than any other industry. It grew to be the biggest single business in the world, paying the highest wages that have ever been paid. When the automobile business is not active, no other businesses are. It has become the backbone of our industrial structure.

Now the automobile business is not possible without production machine tools. Volume sales in the automotive industry cannot be made unless automobiles can be sold for a low price—a price at which the working people can buy. When automobiles can be sold for $300 a piece, practically everybody can own one, and many families can have two. This is not a theory, but has been proved by experience. When Ford built an automobile for $300, he turned out 8000 cars a day, and the Ford business alone kept iron mines working to capacity to produce the ore for the steel mills that turned it into steel for the Ford plants. Meanwhile, the Ford employes were paid the highest wages in the history of industry.

Not only did the Ford plant, at that time working to capacity, employ thousands of workers, but because of the enormous number of cars turned out a day, it kept the accessory builders working at top speed; rubber tires were being manufactured in large quantities; and the makers of hubs and wheels, ignition equipment, springs, radiators, and upholstery, were all busy. When the wheels are turning in the automobile plants, they turn in hundreds of other plants, too.

The building of Ford cars for $300 a piece was made possible only by the use of production machine tools. The production machine tool really built the automobile industry; and, through the prosperity of that industry, created great activity in many lines of endeavor far removed from the industry itself. The railroads were kept busy hauling materials for automobiles, as well as completed cars; in the oil fields there was great activity drilling for oil to be manufactured into gasoline and lubrication means. And, again due to the large number of automobiles being built by production machinery at a very low price, there were more roads built in the United States in a few years than in the whole previous history of our country. Road-building employed tens of thousands of people.

Furthermore, the perfection of production machinery for the building of automobiles made possible the application of similar production machinery to the airplane business, the vacuum sweeper, the washing machine, the camera, and many other devices now in common use. Through the large production shops, we were able to employ not only all our native-born citizens, but hundreds of thousands of people coming from Canada, Mexico, and Europe.

Any intelligent person, by studying this production record carefully, will recognize that production machinery is the only means for producing wealth so that every person can enjoy a standard of living such as we have today. Otherwise, we must be satisfied to live as people lived up to fifty years ago.

For thousands of years previous to the machine age, most of the people lived not much better than animals. They knew nothing of the comforts and conveniences that we consider commonplace today; even when some intelligent person did invent something remarkable, it could not become generally used, because there was no way in which it could be produced at a low cost.

Until the last few decades, most people lived on farms. They had no way of communicating with one another except by mail; they knew nothing about the telegraph or telephone, the railroads, the airplane, or the radio; and, if it were not for production machine tools, they would know nothing about them today. They would have none of these things at present.

Few people seem to understand the simple fact that when anything is being built in large quantities, the flow of raw materials, regardless of where it is obtained, puts millions of people to work —instead of throwing people out of work, as those who do not understand our industrial system seem to believe.

Motorized Speed Reducers Make Savings in Cost and Weight Possible

By MAURICE HUGHES NELSON
Wagner Electric Corporation, St. Louis, Mo.

WHEN in recent years a study was made with a view to improving the drives for machines requiring low operating speeds, it was found, paradoxical though it may seem, that high-speed motors offer the most economical driving medium. The use of high-speed electric motors in combination with suitable gearing makes it possible to retain the advantages of the conventional low-speed drive, and, in addition, secure the economies inherent in high-speed motors. This modern slow-speed drive consists of a standard 1800-R.P.M. motor used in conjunction with helical or worm gearing. The 1800-R.P.M. motor is small in size, and therefore light in weight; it has good operating efficiency and power factor; and it is usually composed of standard parts most favorably designed for high operating speed.

The gearing is simple, consisting of single, double, or triple reduction trains of gears in a suitable housing which usually forms an integral part of the motor reducer unit, thus eliminating the relatively heavy sub-bases characteristic of the older style motor and speed reducer units, which were connected by flexible couplings. Accordingly, both the weight and the space required are reduced materially in modern motorized speed reducers.

When machines must be driven at low speeds, there are several solutions possible: A slow-speed electric motor may be used with (1) flat or multi-V belt; (2) chain drive; (3) back-gearing; (4) conventional reduction gears flexibly coupled to the motor; or (5) the motor and reducer combined into one unit. Each of these types has its advantages and disadvantages. Since it is important to obtain the smallest initial cost, the smallest space, and the smallest weight, the new motorized speed reducers usually meet the requirements in the most satisfactory manner.

If a comparison is made between the cost of this new equipment and that of older methods, it will be found that savings anywhere from 40 to 65 per cent can be obtained. The saving in weight of the motorized reducers is from 13 to 77 per cent of the older equipment, the greater savings applying to the larger units.

As the total weight of the combined motor and reducer in the modern motorized reducers is so much less than that of slow-speed electric motors, and as the design also economizes on space, the space requirements for the new equipment are considerably less. It is also possible to arrange the motorized speed reducers in various ways to save space—vertical arrangements, for example, being entirely practicable.

The motorized speed reducer, therefore, will undoubtedly gain in popularity for driving slow-speed machinery, as it presents these marked advantages at a considerable saving to the user.

Special Tool, Die, and Machine Shop Institute

For the first time in the history of the tool, die, and special machinery industry, there have been gathered together into one group concerns in this line of business from every part of the United States. The first national convention was held in Cleveland, Ohio, August 25, 26, and 27. At this convention, delegates were present from practically every tool- and die-making center in the United States.

The officers elected were as follows: J. J. Kohl, International Tool Co., Dayton, Ohio, president and treasurer; H. A. Stoddard, Interstate Mechanical Laboratories, New York City, vice-president; and Roy T. Wise, Cleveland, Ohio, managing director. The offices of the Institute are at 7016 Euclid Ave., Cleveland, Ohio.

The Institute is cooperating with all the major bureaus and divisions of the National Recovery Administration in Washington, and has already found it possible to be of service to members in matters pertaining to adjustment of provisions in the President's Blanket Code Agreement. Plans are being formulated with a view to correcting many abuses prevalent in the industry, both by means of information, and, when necessary, by enforcement of code provisions. The interests of the employer, employe, and customer are being coordinated.

Copies of a pamphlet containing the articles of incorporation, by-laws, and proposed code can be obtained from Roy T. Wise, 7016 Euclid Ave., Cleveland, Ohio. Concerns engaged in the tool, die, and special machine industry are invited to become members. It is stated that the dues are very moderate, so that no concern in this line of business should refrain from becoming a member, even under present conditions.

NEW TRADE LITERATURE

Any of these Publications can be Obtained by Writing to the Manufacturer or to MACHINERY. Send for Your Copy Today.

PLASTIC PRODUCTS. General Electric Co., River Works, West Lynn, Mass. Bulletin GEA-937C, containing complete information on the plastic products produced by this company under the trade names "Textolite Laminated," "Textolite Molded," and "Cetec." The bulletin describes the special characteristics of these materials and the applications for which each is especially suited. The properties, such as water absorption, heat resistance, compressive strength, density, etc., are listed in tabular form for convenient reference. One section of the book is devoted to Textolite gears and another to the machining of Textolite. The last part of the book contains tables of prices for Textolite tubing, washers, disks, gear blanks, and pump valves of various diameters and thicknesses.

CHAINS AND SPROCKETS. Diamond Chain & Mfg. Co., Indianapolis, Ind. Catalogue 583, containing ninety-six pages of complete information on Diamond chains and sprockets, including such data as where to use Diamond roller chain; how to select proper sizes and sprockets; formulas and tables for determining chain length; tables giving complete data on chains of various pitches, single and multiple strand; and sprocket data for all pitches of chain. One section of the catalogue is devoted to special chains for conveying systems, and another to chains made of special materials, such as stainless steel, aluminum, Monel metal, etc.

ROLLED STEEL. Carnegie Steel Co., Pittsburgh, Pa. Booklet entitled "The Use of Rolled Steel in Machine Construction," containing a reprint of a paper read by H. G. Marsh of the Carnegie Steel Co. before the American Iron and Steel Institute, which gives a complete review of the use of welded rolled steel in the building of machine frames and parts. The booklet is profusely illustrated with examples of machinery frames and parts made from welded steel construction.

LATHES. South Bend Lathe Works, 425 E. Madison St., South Bend, Ind. Bulletin 101-A, descriptive of the new model South Bend underneath-belt motor-driven lathe. Specifications and price lists are included for the eight different sizes and types. In addition to the underneath-belt motor-driven lathes, a complete line of countershaft-drive lathes is shown, and attachments, chucks, and tools fitting both types of lathes are listed.

LUBRICANTS. Pure Oil Co., Chicago, Ill. Mechanical Bulletin No. 57, discussing the lubrication of bearings with the purpose of promoting correct lubrication. The subjects covered are dealt with under the following headings: The Mechanism of Journal Bearing Lubrication; Lubrication as Related to Types of Bearings; Bearing Metals; Lubricants for Bearings; and Application of Lubricants.

PUMPS. Chain Belt Co., Milwaukee, Wis. Bulletin 240, covering the Rex line of speed prime pumps. The purpose of the booklet is to give the contractor and pump user valuable data that has not heretofore been presented in simplified form. A sample problem is presented, accompanied by charts and tables. to assist the contractor or pump user in selecting the right pump for the job.

AIR COMPRESSORS. Ingersoll-Rand Co., 11 Broadway, New York City. Catalogue illustrating and describing a new type of air compressor known as the "Motorcompressor," which consists of a stationary air-cooled compressor with a built-in motor. The distinctive features are clearly shown by two full-size page illustrations, and a table of sizes and ratings is included.

HYDRAULICALLY OPERATED CHUCKS AND POWER DEVICES. Logansport Machine Co., Logansport, Ind. Catalogue AH-30, describing a complete line of power devices, cylinders, and valves for the operation and control by hydraulic pressure of machine tools and other equipment. Descriptions of the various devices are given, as well as dimensions and specifications.

SCREW CONVEYORS. Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Data Book No. 1289 on Caldwell helicoid and sectional-flight screw conveyors. This book of 128 pages is profusely illustrated and contains a great mass of engineering data, as well as list prices. It is doubtless the most complete treatise ever published on this subject.

HIGH-SPEED STEEL TAPS. Winter Bros. Co., Wrentham, Mass. Pamphlet supplementing Catalogue 16-A, containing tabulated data, including price lists, of Winter high-speed steel cut-thread, commercial ground-thread, and precision ground-thread taps. Tables of limits and tolerances for ground-thread taps are included.

PUMPING UNITS. Goulds Pumps, Inc., Seneca Falls, N. Y. Bulletin 204, outlining the features of construction of Goulds close-coupled motor-centrifugal pumping units. The bulletin also contains a performance chart showing the size of pump to use for different heads and capacities.

STEEL BARS, PLATES, ETC. Inland Steel Co., 38 S. Dearborn St., Chicago, Ill. Booklet entitled "Sizes We Roll and Standard Extras." The booklet lists all the sizes and sections of open-hearth steel bars, structural shapes, plates, and semi-finished steel available, and gives tolerance data.

WELDING EQUIPMENT. Lincoln Electric Co., Cleveland, Ohio. Application Sheet No. 35, in a series on the elements of design, discussing the design of wheels of arc-welded construction.

CONVEYOR CHAINS. Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Folder 1365, on conveyor chains for handling cans, bottles, jars, etc. Silent, roller, Ewart, and pintle types of chains are included.

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts and Material-Handling Appliances Recently Placed on the Market

Sellers Planer-Type Milling Machine

A planer-type milling machine that accommodates work up to 120 inches wide by 90 inches high by 29 feet long was recently built by William Sellers & Co., Inc., Philadelphia, Pa., for the National Transit Pump & Machine Co.'s plant at Oil City, Pa. This machine is equipped with four independent unit heads, each of which is provided with a constant-speed reversible motor that drives the spindles through gears mounted on short shafts. This construction eliminates long splined shafts and gearing. The head shafts, as well as the motor armature, run in ball or roller bearings. Spindle speeds are selected through change-gear levers located on the heads. Since each head is an independent unit, different sizes of cutters can be used at the same time.

The heads are designed to bring the spindle unusually close to the face of the cross-rail or the housings. The bed, table, uprights, and cross-rail embody a number of features that give unusual rigidity and accuracy to the machine. The table rack abuts against a fixed stop at the end of the table and is held by clamps. This construction eliminates loosening or shearing of bolts and permits the rack sections to fit solidly against each other. To improve the appearance of the machine, the counterweights for the side-heads are carried inside the uprights.

The cross-rail is equipped with air-operated clamps which, when locked, draw the cross-rail solidly against the front faces of the uprights and also draw the back edges of the cross-rail against the inside bearing surfaces of the uprights. The cross-rail is actuated up and down by a motor on the cross-girt.

The table is driven by the Sellers spiral gear drive. An adjustable-speed motor and change-gear box give the necessary feeds and traverse. The feed and traverse of the rail-heads are obtained by an adjustable-speed

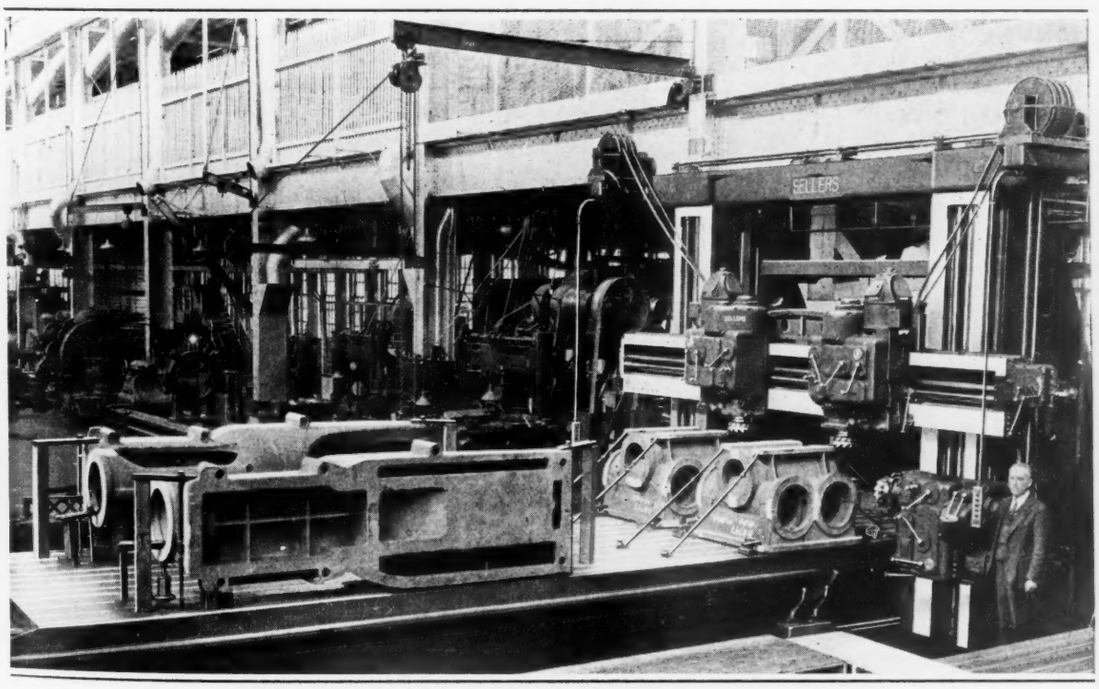


Fig. 1. Sellers Planer-type Milling Machine Equipped with Four Heads Driven by Individual Motors

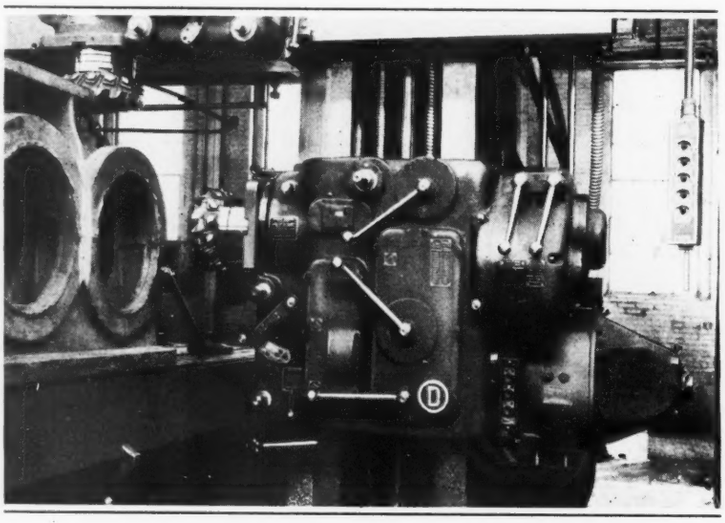


Fig. 2. Close-up View of One of the Rail-heads, Showing Convenient Grouping of Controls and Adjusting Means

motor and a gear-box at the end of the rail. A similar mechanism for the side-heads, mounted on the cross-girt, allows the side-heads to be fed or traversed independently of the rail-heads and vice versa. The independent feed for the side- and rail-heads makes contour milling practical. The spindle quills are also provided with a power feed and traverse.

All motors are controlled from one panel and operated by convenient push-buttons and pendent switches. The motors are interlocked and limit switches prevent over-travel of the various units. If the cutters should be overloaded, the feed motors would automatically slow down and then speed up again when the overload condition had passed. Should an overload continue for too long a period or exceed a predetermined maximum, the feed and spindle motors would stop automatically. The feed motors cannot be started until the spindles of the heads selected for an operation are actually rotating; thus it is impossible to feed work in to a cutter that is not revolving.

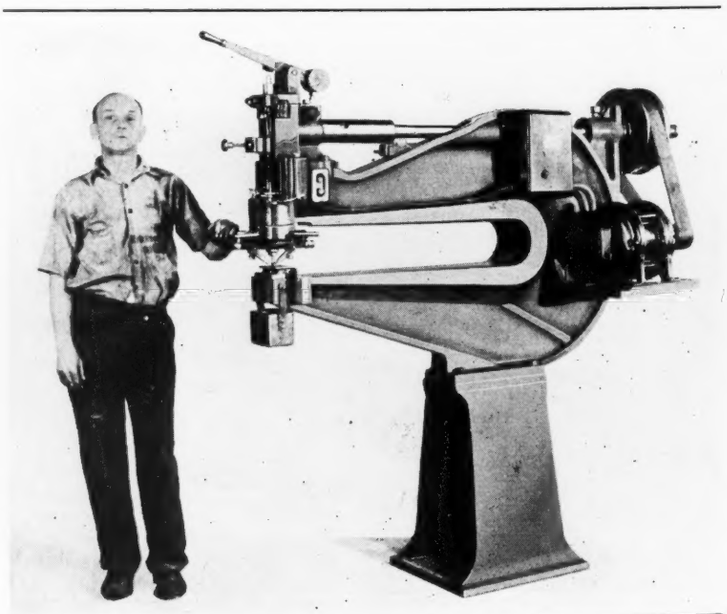
Each side of the machine is provided with a pendent push-button station that controls the spindle motors as well as the feed motors, so that the operator can start or stop the machine from either side. To further facilitate the operation of the machine, stainless steel scales are attached to the table, cross-rail, and right-hand housing. Holders are also provided for indicators, so that fine adjustments can be made conveniently. Circular scales built into each head show the amount of quill projection at all times. For fine settings, however, dials reading to 0.001 inch are provided on the quill hand adjustments.

Forced-feed lubrication is furnished for the bed and table by a motor-driven pump that must be started before the table motor can be operated. Each head has its own lubricating system, consisting of a pressure pump and reservoir, and the gear-boxes are similarly equipped. Cutting compound is supplied by an independent motor-driven pump.

Gray Turret-Head Metal Cutter

Mild steel 3/16 inch thick, in sheets up to 6 feet wide and of any length, can be cut at the rate of 30 feet a minute in the latest turret-head metal cutter or nibbler built by the Gray Machine Co., Box 596, Philadelphia, Pa. In this machine, the turret turns to permit various shapes to be cut in sheets too large to be swung through the throat, the throat being 36 inches deep.

One of the improvements in the design consists of a mechanism at the front of the machine by means of which the turret can be locked in ten fixed positions, the locking mechanism remaining fixed at the front of the machine. In former machines,



Turret-head Metal Cutter or Nibbling Machine Built by the Gray Machine Co.

the locking mechanism rotated with the turret and had only eight locking positions.

Another important improvement is a two-speed telescoping flywheel. The heavy flywheel, which operates the cutter at 550 revolutions per minute in operations on stock of maximum thickness, can be slid along the line-shaft to uncover a smaller belt pulley in line with the motor. The smaller pulley will drive the cutter-shaft at 1200 revolutions per minute, thus greatly increasing the cutting speed for light stock. At the same time the large flywheel maintains the desired momentum.

Globe Horizontal Tapping and Screw-Inserting Machine

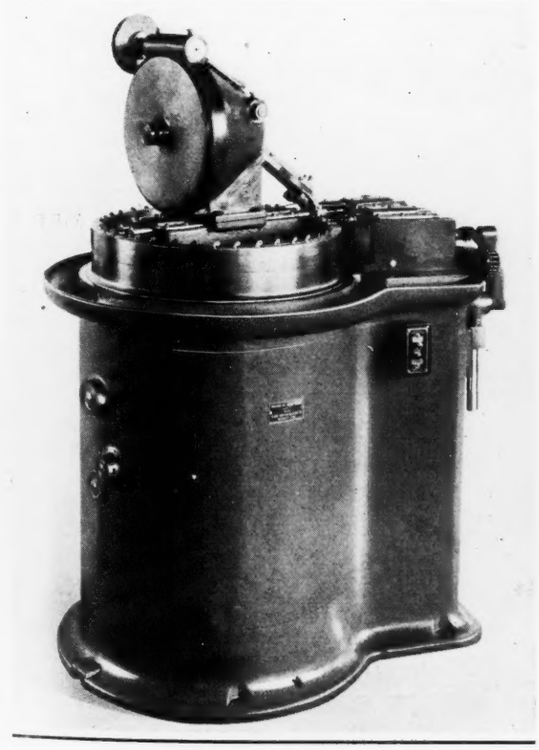
An automatic horizontal type of machine designed for light drilling, tapping, threading, screw-inserting, burring, etc., has been brought out by the Globe Tapping Machine Co., 751 Central Ave., Bridgeport, Conn. In this high-production machine, the work of the operator consists only of placing the parts in a dial ring, all other operations, including ejection, being automatic. Uniform parts can be fed to the dial ring by a hopper.

The machine is driven by a motor mounted on a tilting plate in the base. A gear on the motor can be changed to obtain different operating speeds. A feature of the machine is that the working units can be placed vertically, as well as horizontally, or at an angle. The machine illustrated is tooled up for performing several operations on electrical contact blades at the rate of eighty pieces per minute. It could easily be arranged to handle other parts.

Universal Tool-Room Milling Machine

Universality is the important feature of the Deckel tool-room milling machine shown in Fig. 1, which is being introduced on the market by the Preis Engraving Machine Co., 157 Summit St., Newark, N. J. This machine has two spindle heads—one horizontal and the other vertical—the vertical head being removed from the machine when the horizontal spindle is to be used. The horizontal spindle head is adjustable in and out by hand. The vertical spindle can be swiveled 90 degrees to the right or left, and it is also adjustable up and down.

The swivel table can be fed vertically and crosswise, either automatically or by hand. It can be tilted toward or away from the column. Fig. 2 illustrates a horizontal milling operation in which the table is tilted away from the column. For many operations, the swivel table can be removed and the work or a fixture mounted on the vertical-face table to which the swivel



Globe High-production Tapping and Screw-inserting Machine

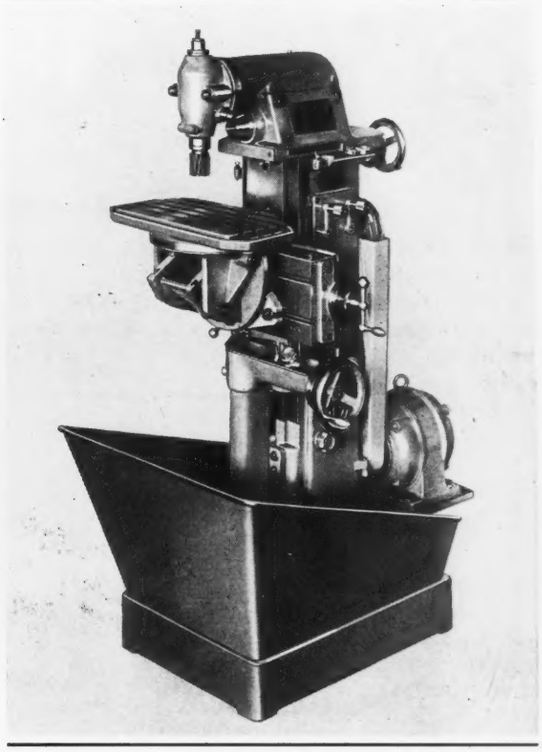


Fig. 1. Deckel Milling Machine, Adaptable for a Variety of Operations

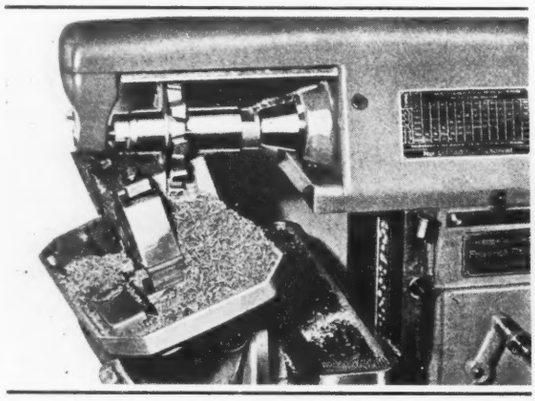


Fig. 2. A Horizontal Milling Operation in which the Table is Tilted away from the Column

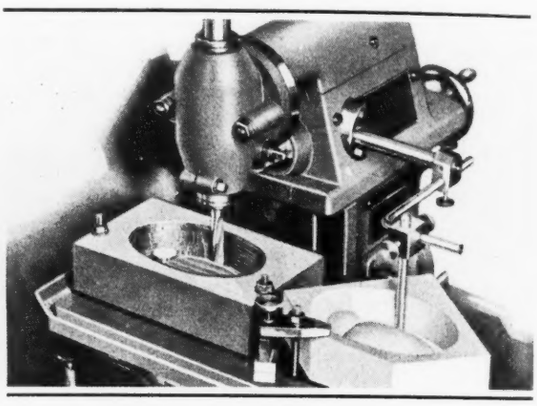


Fig. 3. Employing the Vertical Spindle to Mill an Outline Accurately from a Master

table is attached. Six rates of table feed are available through change-gears, and there are six cutter-spindle speeds. A dividing head can be supplied for work requiring indexing.

In Fig. 2, the outer end of the cutter-arbor is shown supported by an over-arm. For face-milling operations, the over-arm is, of course, omitted. Fig. 3 shows the vertical spindle head being used for finishing a mold. In this operation, the cutter is accurately guided from a master made of plaster-of-paris. Horizontal milling can also be controlled in a similar manner. Boring and profiling operations can be performed accurately by mounting outline drawings horizontally above the work and using a tracing style.

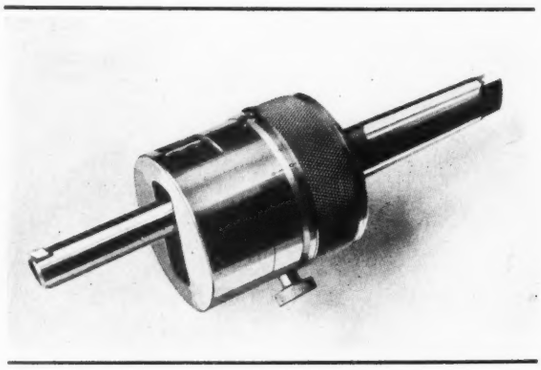
The production of blanking punches of intricate shape is facilitated through the use of a radius milling device by means of which the center of each surface to be milled can be easily positioned true with the axis of the dividing head. The machine can also be used as a sensitive drilling machine by inserting a drill in either the horizontal or vertical spindle and applying the hand feed.

Precision Universal Tool-Head

A tool-head in which the tool can be adjusted radially to obtain any desired offset while the head is rotating in a machine spindle has been placed on the market by the Precision Tool Co., Bridgeport, Conn. This tool-head is intended for use in boring, counterboring, facing, under-cutting, turning, trepanning, and recessing operations. It can be used in a milling machine, jig borer, drilling machine, or lathe. Graduations to 0.0001 inch facilitate accurate settings of the tool-slide, which moves in a slot at right angles to the axis of the head. The graduations are approximately 1/8 inch apart, facilitating minute adjustments.

When the tool is rotating, there is no internal movement, the shank and body turning on ball bearings within an adjusting sleeve that is normally stationary. Radial adjustments of the tool-slide in increments of 0.001 inch are made directly by means of the large knurled sleeve. Finer adjustments are effected by means of the large thumb-nut. The graduated micrometer slip collar can be set to zero when starting a cut at any point.

Exceptional stiffness is claimed for this tool-head because of the fact that the shank is forged integral with the body. In addition to tools being held parallel or in line with the axis of the tool-head, they can be held at right angles by employing an extension tool-block which is fastened securely to the tool-slide. Cutter-bars of various styles are available for different operations. The body of this tool-head is 3 3/8 inches in diameter by 3 7/8 inches long. Tools of any size or shape up to 3/4 inch can be accommodated. The radial adjustment of the tool-slide is 3/4 inch, which is equivalent to 1 1/2 inches on the diameter of work. The boring and facing range without the extension tool-block is 4 inches, and with the extension tool-block, 12 inches. The weight is approximately 9 pounds.



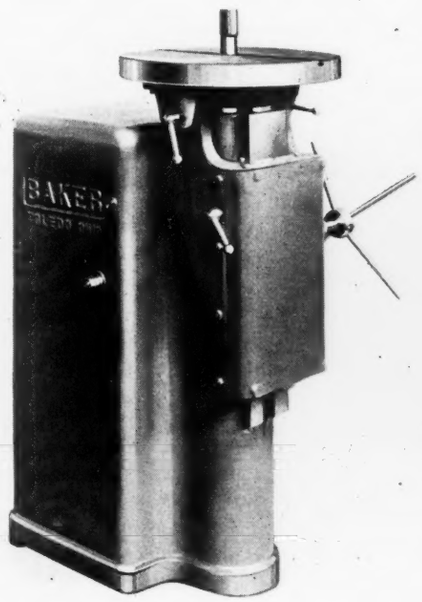
Tool-head in which the Tool-slide can be Adjusted while the Head is Rotating

Baker Contour Grinder of Increased Size

Baker Bros., Inc., Toledo, Ohio, has just brought out a No. 3 contour grinder which is considerably larger than the No. 2 machine described in June MACHINERY, on page 683. The latest model will take abrasive wheels from 1/2 to 4 inches in diameter, having a face width up to 3 inches. The table is 18 inches in diameter. The driving motor is of 1 1/2 horsepower rating. Spindle speeds of 3600, 5400, and 7200 revolutions per minute are available. The weight of the machine is 900 pounds, as against 350 pounds for the earlier model.

These machines are designed for the rapid and accurate grinding of all kinds of irregular surfaces. They are especially adapted for use in tool and die shops. The grinding wheel is mounted on a vertical spindle which has an up and down reciprocating action in addition to rotating. The spindle is reciprocated by means of a cam. In dressing the wheel, or in using polishing drums for finishing operations, the reciprocating mechanism is disengaged.

Various types of solid wheels and cup-wheels, as well as polishing drums, can be mounted on the spindle. The table can be adjusted up and down and tilted for grinding angular relief on dies. The angular adjustment is 10 degrees each side of center.

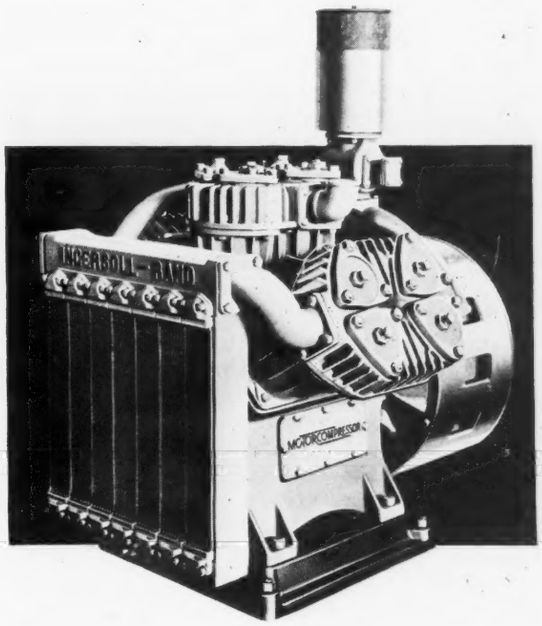


Baker Contour Grinder of Greater Capacity than Previous Model

Ingersoll-Rand Air-Cooled Air Compressor

A two-cylinder, two-stage motor-driven air compressor that does not require cooling water and hence is especially adapted for applications where water is scarce, costly, or objectionable has been developed by the Ingersoll-Rand Co., 11 Broadway, New York City. This new equipment is called the "Motorcompressor" and has, as the name implies, a built-in motor. The motor rotor is carried on the compressor shaft and the motor frame is bolted directly to the compressor crankcase. This construction eliminates a coupling and motor bearings.

Various sized units are built ranging from 20 to 50 horsepower, with piston displacements from 113 to 310 cubic feet per minute. Discharge pressures are obtainable up to 125 pounds per square inch.



Air-cooled Air Compressor with Built-in Electric Motor

Armite Lubricant

A lubricant in which metallic lead is the protective element is being placed on the market by the Armite Laboratories, 1450 E. 61st St., Los Angeles, Calif., under the trade name of "Bestolife." In this lubricant the lead is said to be broken down into such fine parts as to be virtually a soluble or liquid lead within a lubricant vehicle. A thin protective film of lead is formed on all contacting surfaces.

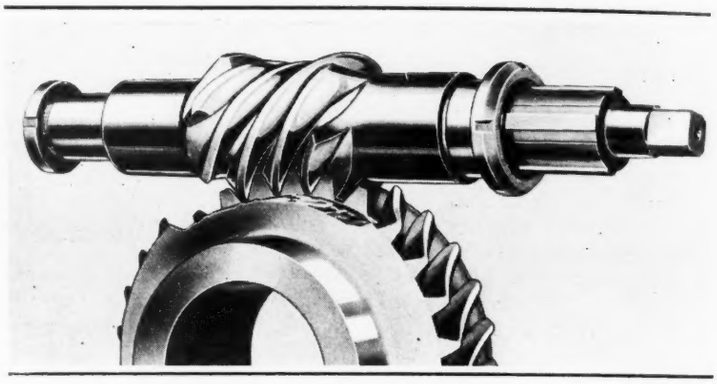
This lubricant is free from chemical reactions. The minimum amount of lead is 15 per cent, and the maximum 65 per

cent. It is claimed that this lubricant will withstand temperatures up to 430 degrees F. and will not entirely lose its lubricating stability until the melting point of lead is reached. It is suitable for gears and roller bearings and also can be used as a belt dressing.

Cone Worm-Gears

The Michigan Tool Co., 7171 Six Mile Road, E., Detroit, Mich., has developed special machines for producing ground-form hobs and worm-generating cutters for cutting Cone worm-gears. This concern is prepared to furnish complete gear sets either on a production basis or for experimental purposes. It will also license other companies to manufacture these gears.

In the Cone worm-gear, the nature of the contact is such that, in the passage of the worm through the wheel, every portion of the worm thread and tooth flank is in contact. The contact is continuous for a considerable distance above and below the midplane of the worm-wheel. The remaining portions are in periodic engagement. At any instant, the contact is said to be approximately thirty times as great as that found in the conventional straight or parallel type of worm-gearing. The length of the worm and the width of the wheel-face are not restricted.

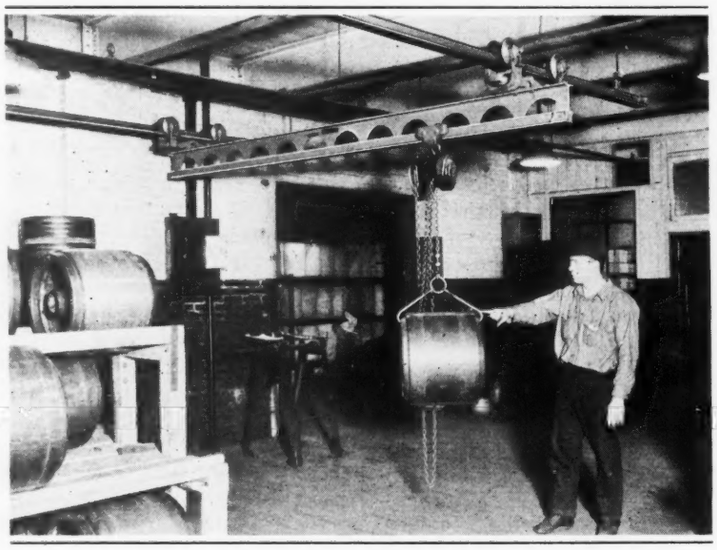


Six-thread Cone Worm-gearing with the Wheel Cut away to Show Four Teeth in Contact

Minimum unit pressure, heat, and wear, together with high efficiency, are the main advantages claimed for Cone worm-gears. Gears of this type are operating successfully at speeds up to 30,000 revolutions per minute.

Cleveland Tramrail Equipment

Additions to the line of overhead materials-handling equipment made by the Cleveland Electric Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio, include a Type CHS crane, a Type THS transfer bridge, an 8-inch arch beam, Type D switch, and a Type WTH motor-driven carrier. The new line of cranes and transfer bridges have the feature of light weight and are suitable for loads up to one ton when the bridge span is not greater than 16 feet. Hand-propelled carriers can be provided, either with or without chain- or motor-operated hoists. The runways may be either standard rails or arch beams.



Cleveland Tramrail Crane and Transfer Bridge Made for Loads up to 1 Ton and Spans up to 16 Feet

The cranes and transfer bridges, as will be seen in the illustration, are made from the new 8-inch arch beam. This beam is identical in construction with the 10- and 11 1/2-inch arch beams. It is intended for supporting loads up to and including 2 tons under proper conditions. This type of rail was designed primarily for use where it is not practical or economical to install a superstructure between roof trusses for supporting standard Tramrails. The arch beam is built of a half-section of structural steel beam, in the leg of which semicircular sections are punched. To this structural shape, a standard high-carbon steel Tramrail is welded.

The Type D switch permits a closer switch grouping and rail spacing than is possible with the standard sliding-type switch made by the concern. The new switch is suitable for all Tramrail hand-propelled carriers and

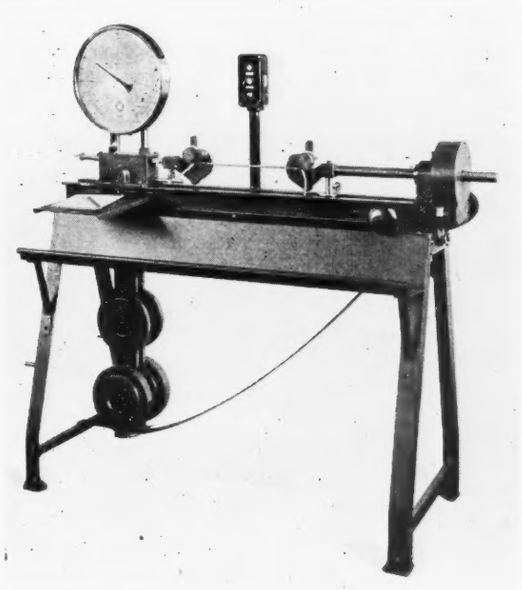
for certain types of electrically operated carriers. It consists of two main parts—a rigid outer frame and a sliding inner member fitted and guided to maintain proper alignment of the switch and incoming rails. The inner member has a top plate which protects the slide way from dust, dirt, and the elements.

The new motor-driven carrier can be operated from a creep to a speed not in excess of that at which the operator can walk. This carrier can be supplied with electric hoists of 500, 1000, or 2000 pounds capacity. The standard control is by means of push-buttons suspended from a swinging arm. A time-limit automatic acceleration control is furnished for the travel motor, while the hoist motor control can be of either the single-speed type or the time-limit automatic accelerating type.

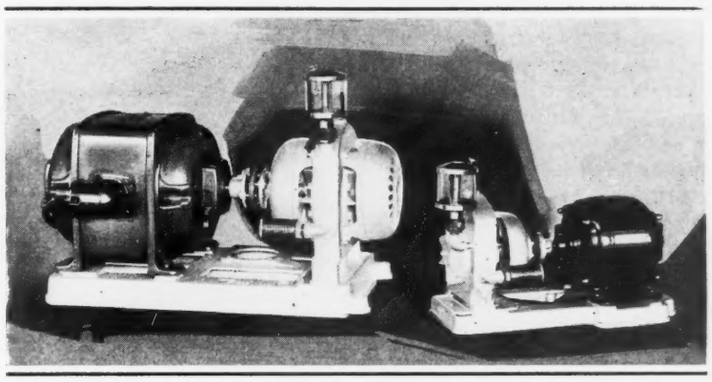
Amthor Tensile-Strength Tester

A horizontal power-driven machine for determining the tensile strength of a wide variety of cable and sheet materials has just been designed by the Amthor Testing Instrument Co., Inc., 309 Johnson St., Brooklyn, N. Y. This equipment, which is shown in the illustration, is constructed on the pendulum principle. Its operation is automatically controlled.

The dial is hand-calibrated and has double-capacity ranges for the sensitive testing of the lighter materials. In making a test, the only hand operation is to insert the specimen and press a start-button. When the specimen breaks, the tensile strength, in pounds, is shown on the dial. The motor and pulling clamp stop automatically, and the pendulum arm automatically returns to the next test position. An elongation indicator or an autographic recorder can be provided. The capacity is 1500 pounds.



Amthor Power-driven Machine for Testing the Tensile Strength of Parts



Gast Rotary Pumps for Developing Air Pressure or Creating Vacuum

Gast Rotary Compressor Vacuum Pumps

A series of rotary compressor pumps designed to develop air pressures up to 25 pounds per square inch under constant duty or to create a vacuum up to 26 inches is being placed on the market by the Gast Mfg. Corporation, Bridgman, Mich. Under intermittent duty, air pressures can be developed up to 35 pounds per square inch.

Compactness and few working parts are advantages of these pumps. They are cooled by forced air, and can be connected direct to motors running at speeds from 1200 to 1750 R.P.M.

Paasche Automatic Air Painting Machines

Air painting machines which are automatic except for loading and unloading are being built in a number of types by the Paasche Airbrush Co., 1909-1923 Diversey Parkway, Chicago, Ill. The Type F-643 is intended for applying cold materials, such as paints, lacquers, and dyes, to sheets of metal, wood, paper, etc., for decorative and preservative purposes. A uniform coat, as light or heavy as desired, can be applied at any lineal speed to suit the operator. The automatic air guns are so controlled that they spray only as each sheet, regardless of its size, passes into the coating position.

The Type F-2848 machine is used for applying hot materials, such as paraffin and asphalt, to sheets of any kind for waterproofing and

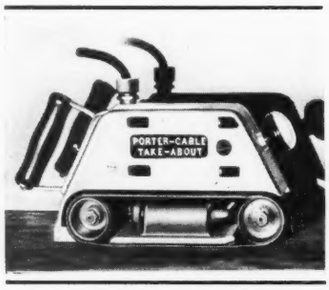
similar purposes. The sheets pass through a preheater that heats them, so that proper fusing will take place when the material is applied. A uniform fan spray, up to 60 inches wide, can be applied as light or heavy as desired. A machine of rotary type has also been developed for applying paraffin to cups, cans, pails, and similar products.

Automatic machines for both air coating and drying are made for handling a large variety of pieces. One of these machines will coat and dry up to 10,000 pieces per hour.

Porter-Cable "Take-About" Sander

A Type T-3 "Take-About" sander with modernistic lines has been added to the belt-sanding equipment built by the Porter-Cable Machine Co., Syracuse, N. Y. The new model has the same features as the Type B-10, which was placed on the market about two years ago, with the exception that the dust collection system is omitted.

With a view to obtaining a fine degree of balance in this portable tool, the motor has been placed horizontally. The resulting advantages are said to be easy operation; the obtaining of smooth flat finishes, regardless of whether or not the operator has used a sander before; and fast sanding. The 1/2-horsepower universal motor which drives the sander can be operated from a lamp socket of alternating or direct current.



"Take-About" Sander of Recent Design

Tools for Turning and Dressing Car Wheels

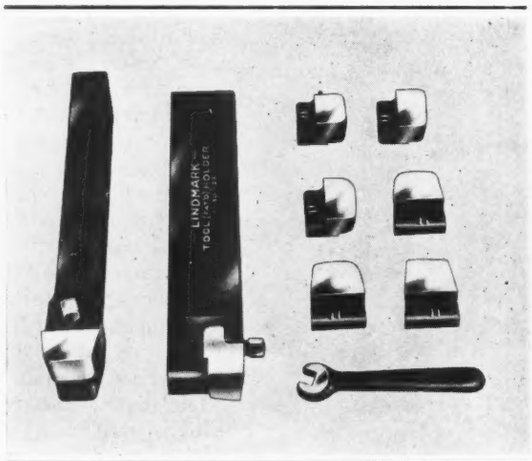
A tool-holder and tool bits for turning and dressing car wheels and tires have been developed by the Apex Tool & Cutter Co., Inc., Shelton, Conn. The illustration shows a pair of holders with an assortment of tool bits ground to meet various conditions. Standard holders are made to fit the toolpost of Sellers, Niles, and Putnam wheel-turning lathes. They can be used with either right- or left-hand tool bits. After the holder has been placed in the toolpost, it remains there indefinitely, as the tool bits can be interchanged without disturbing the holder.

The tool bits have two slots or stations which allow for adjustment sidewise. This feature permits repeated grinds and extends the life of the bits considerably. The bits are forged of high-speed steel or cobalt steel. They are furnished hardened and ground, ready for use. A holder is provided for redressing the bits by hand or by machine.

USL "Protected-Arc" Welder

A "Protected-Arc" welder capable of welding the thinnest automobile-body metal or the heaviest locomotive frame is being placed on the market by the USL Battery Corporation, Niagara Falls, N. Y. Operation between these two extremes is possible, because this 300-ampere welder has a range from 40 to 550 amperes. The welding generator capacity of 40 volts enables the use of all kinds of bare or coated electrodes without danger of overloading. Two convenient controls permit any voltage and current combination, while the arrangement of the welding leads allows quick reversal of polarity.

The advantages claimed for the welder include a constant flow of electrical energy and a reduction in current lag to the



Tool-holders and Interchangeable Bits for Turning Car Wheels and Tires

Completely Enclosed Arc Welder Made by the USL Battery Corporation

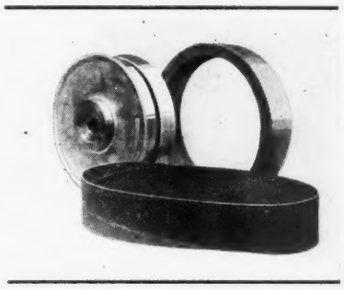
minimum. Moderately skilled operators can produce strong homogeneous welds at high speeds, using heavily coated electrodes.

The welder is completely enclosed in a heavy sheet-steel cylinder, so that the machine cannot be damaged by falling objects, moisture, or dust. A canopy is not required to protect the welder from the weather. The mechanism is completely accessible through a hinged cover on the commutator end. A fan and ventilating system keep the welder cool, even during long periods of operation.

Turkish-Emery Polishing Sleeves

Endless abrasive sleeves coated with genuine Turkish emery have been placed on the market by the Cleveland Container Co., Abrasive Division, 10730 Berea Road, Cleveland, Ohio, for use with the expanding polishing wheels made by the concern. The sleeves are made by the same process as the company's aluminum-oxide Nolap abrasive sleeves. In this process, a web of plain drills cloth and a web of abrasive-coated cloth are fed through an automatic machine to form a double helix, so overlapped that the seams are staggered.

The new sleeves are heavily coated on a drills cloth backing.



Turkish-Emery Abrasive Sleeve and Expanding Polishing Wheel

They have been developed to give a high luster on parts made of aluminum, steel and other metals. They can be used dry or with grease, oil, or emery cake.

Electric-Hydraulic Chuck-Operating Unit

Machines that require a single-unit chuck-operating mechanism can now be equipped with a motor-driven hydraulic unit recently developed by the Tomkins-Johnson Co., Jackson, Mich. This unit is capable of developing working pressures up to 250 pounds per square inch.

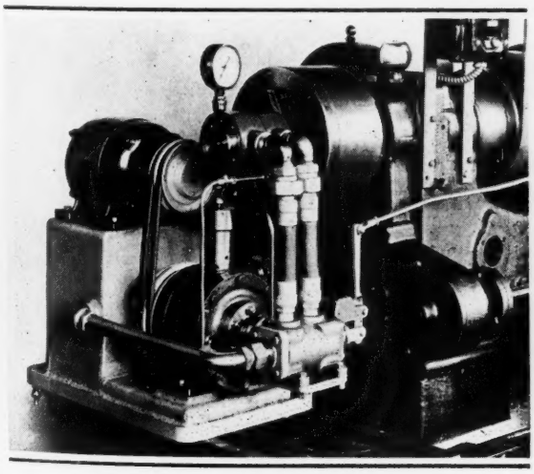
Oil is pumped from a tank, at the pressure required, through a valve and into a distributor and cylinder to close the chuck. To release the chuck, the valve is operated, causing the flow of oil to be reversed, so that it will enter the opposite end of the cylinder. The exhaust oil returns to the tank. A predetermined pressure level is maintained at all times.

The motor, although it runs continuously, is not under load except for short intervals when the pressure, having dropped, is being turned to the desired level. The illustration shows this equipment installed on a lathe.

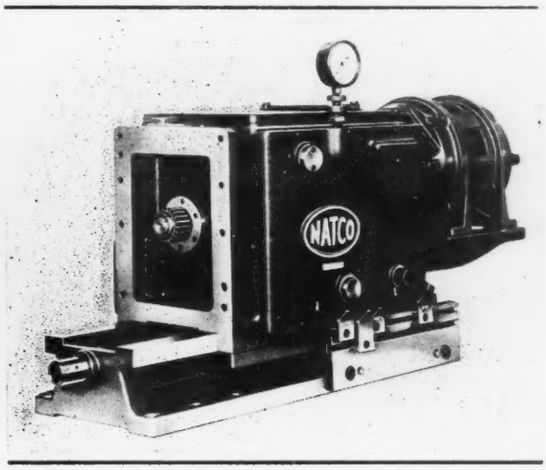
Natco Self-Contained Hydraulic Units

Self-contained hydraulic units designed to be arranged in groups to drill all the holes in the various sides of a piece at one handling are the latest development of the National Automatic Tool Co., Richmond, Ind. These units are interchangeable and their application is flexible. Should the part for which the units are arranged be altered or discontinued, it would only be necessary to rearrange the units and equip them with different drill heads to adapt the machine to an entirely different piece of work. The units are made in sizes equipped with motors from 5 to 20 horsepower.

The cylinder of the units is bolted to a sliding head. One motor drives the drill head and the pressure pump. The main shaft extends through the unit from the rear to the front end, at



Motor-driven Hydraulic Chuck-operating Unit Made by the Tomkins-Johnson Co.



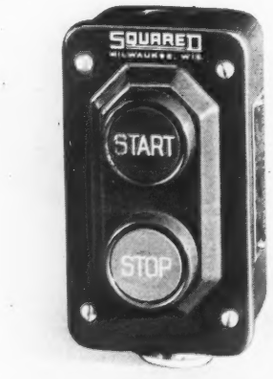
Natco Hydraulic Unit Designed for Interchangeability and Flexibility

which point a gear is provided for driving the drill head. Different spindle speeds can be obtained by changing this gear and the gears in the drill head. The front face of the unit is provided with jig-drilled bolt heads and two bushed dowel-holes to provide for interchanging the drill heads. Likewise, the lower flange is provided with two bushed dowel-holes and jig-drilled bolt holes for interchanging the units on any machine base.

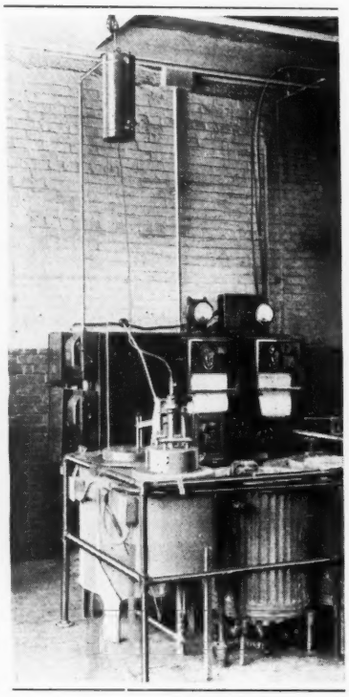
The pressure of the hydraulic system is developed by a constant-volume, vane-type, rotary pump. The length of the rapid traverse and feed of the units is adjustable by means of valve-trip dogs. The stopping position is adjustable in the same manner. The rates of forward feed are also adjustable. Standard units have the following cycle: Rapid traverse forward, first feed, second feed, rapid reverse to starting position, and stop. A "jump" feed can be furnished to provide a second rapid-traverse stroke that interrupts the feeding stroke. A delayed reverse can also be provided.

Square D Start-Stop Push-Button Station

A start-stop push-button station with buttons 1 inch in diameter has been placed on the market by the Square D Co., Industrial Controller Division, 710 S. Third St., Milwaukee, Wis. The buttons and their stems are molded of Bakelite in one piece. They are supported by compression springs, as well as by additional follow-up springs at the contacts. The contacts are silver-to-silver and of the double-break style. The mounting dimensions of this station are 2 1/2 by 4 1/4 by 2 7/8 inches.



Start-stop Push-button Station with Extra Large Buttons



Hump Furnace with Vapocarb Controlled Atmosphere

Vapocarb Method of Controlling Furnace Atmosphere

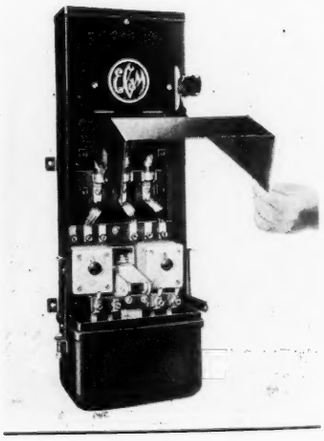
One of the exhibits of the Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., at the National Metal Exposition being held in Detroit, is a Vapocarb-equipped Hump furnace. The Vapocarb equipment so controls the atmosphere in Hump furnaces that there is no trace of scaling, pitting, or decarburization on the work.

Vapocarb liquid is fed by gravity at a controlled rate from a small tank into an electrically heated cracking furnace. This furnace is about one foot in diameter and three feet high. In it, the liquid is gasified and cracked. The resultant gas is carried by a pipe line to a gas-tight retort in the Hump furnace, completely filling this retort.

Work to be hardened is placed in the retort and handled in the usual way. The rate of heating is automatically controlled to insure uniformly heated work with minimum distortion. The recording controller for the Hump furnace and the indicating controller for the cracking furnace are Micromax instruments made by the same concern. The cracking furnace and Hump furnace are installed side by side, as shown in the accompanying illustration, with the recorder and controller placed near by.

Oil-Immersed Across-the-Line Starter

A No. 1 Type ZOS oil-immersed across-the-line combination magnetic starter has been placed on the market by the Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio, for motors up to 15 horsepower, 220 volts, and 30 horsepower, 440 to 550 volts. This equipment consists of an unfused or fusible safety switch, a magnetic starter with overload relays, and heavy-duty



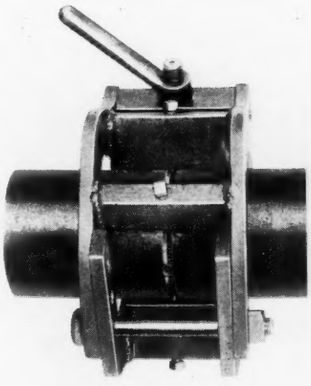
Across-the-line Combination Magnetic Starter

test jacks for applications where it is desired to insert meters in the motor circuit without interrupting the operation of the machine.

Although designed for the severe service encountered in mill duty, this starter is exceptionally small and narrow. It has a front-operated safety switch and a cover that swings vertically. These features make the starter especially suitable for mounting in restricted places, such as between the flanges of columns, on motor-driven machines, or in groups along a wall.

Oster Pipe-Welding Clamp

A clamp designed to facilitate welding operations on pipe is being introduced on the market under the trade name of "Bulldog" by Oster-Williams, 2057 E. 61st Place, Cleveland, Ohio. This clamp is now available in two sizes, one for pipe from 4 to 6 inches, and the other for pipe from 8 to 12 inches. It is planned to produce additional sizes of these clamps in the future.



"Bulldog" Clamp for Use in Welding Pipe

Raule Continuous Type of Internal Grinding Machine

One lever automatically centers the two pieces of pipe to be welded together. Adjustable screw spacers keep the pipe lengths the correct distance apart, the pieces of pipe being held rigidly. The open construction of the clamp leaves a large space for tacking. The smaller clamp weighs 18 pounds, and the larger 26 pounds.

Raule Multiple Internal Grinders

A continuous type of internal grinding machine, so arranged that it can be fed either automatically or manually, has been developed by the Oakmont Mfg. Co., Vista, Calif. This machine is self-sizing and self-ejecting, and the pieces can be inspected automatically after ejection.

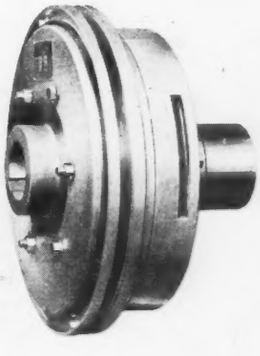
Each spindle grinds one piece of work from start to finish. New pieces are inserted while the machine is in operation. An automatic safety device is incorporated, which insures that the piece will be properly loaded before the grinding wheel descends into the bore.

When a wheel wears below its size of usefulness, the motor and wheel stay up as the machine operates. Both the motor and wheel are replaced simultaneously by a unit equipped with a wheel that has been previously dressed to the right size for the operation.

"Safety Type" Magnetic Clutch

The Magnetic Mfg. Co., Milwaukee, Wis., has developed a line of "Safety Type" magnetic clutches which are mechanically closed by means of springs and opened magnetically in opposition to the springs. In the standard magnetic clutch, the operation is diametrically opposite, the closing being accomplished magnetically and the opening by mechanical means.

This feature of the new clutch is claimed to be particularly advantageous when the clutch is disengaged at infrequent intervals, being used practically con-



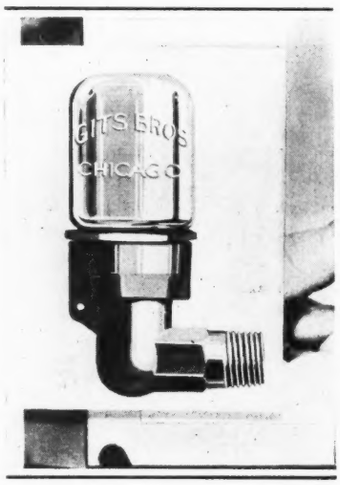
Clutch Closed by Springs and Opened by a Magnet

tinuously. A comparatively small magnet can be used with an intermittent-duty coil developing high pressures for disengagement. Positive clutching is insured, since the clutch will remain engaged, regardless of whether electric current is available or not. A considerable saving in current consumption is another advantage mentioned. The clutch can be released by means of a push-button or an automatic electrical control. It can be built either in the single- or multiple-disk construction, according to the requirements.

Steelgrip Universal Gear and Wheel Puller

Armstrong-Bray & Co., 308-310 Sheldon St., Chicago, Ill., have brought out a "puller" of new design which is intended to facilitate the removal of wheels, pulleys, gears, bushings, and pinions from shafts, etc. The chief advantages claimed for the new design are universality and a large range of work.

The device consists, as illustrated, of a heavy bracket equipped with a large screw and three chains. The chains may be of any length to suit the distance of the work from the end of the shaft. The chains are equipped at one end with standard hooks for gripping spoked wheels or large gears, and at the other end with special hooks for gripping bushings, small gears, and motor pulleys. This puller comes in two sizes, with pulling capacities of 12,000 and 36,000 pounds.



Gits Oiler with Hinged Bottle that can be Easily Refilled

Gits Constant-Level Oilers

Constant-level oilers with glass bottle reservoirs that can be easily refilled or replaced are being introduced to the trade in three styles by the Gits Bros. Mfg. Co., 1846-62 S. Kilbourn Ave., Chicago, Ill. The advantage of these oilers is that the level of oil in the bearing is kept constant. The level is 1/16 inch higher when the shaft that it lubricates is idle than when the shaft is running. The glass bottle shows the reserve oil supply.

The Style HL oiler, which is shown in the illustration, is a hinged type that can be refilled without removing the glass bottle. The bottle is merely tilted down and then refilled through a tube in the cap. When the bottle is swung back into position, it is held in place by a hinge spring.

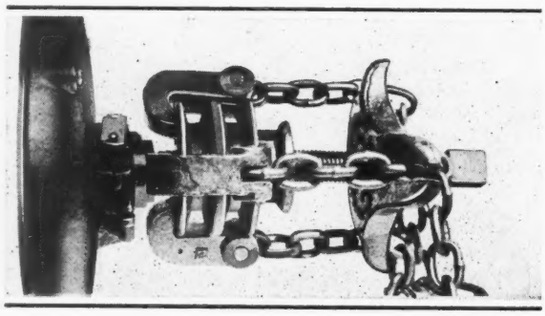
The Style CL oiler is similar in construction, except that the spring is omitted from the hinge. Instead, a clamp is supplied to lock the bottle in place. The clamp is attached to the hinged unit and grips on the under side of the elbow fitting. This oiler is intended especially for installations where excessive vibration exists.

The third type of oiler—Style BL—is a bayonet design. In this, the bottle reservoir must be removed for refilling. This style is especially intended for use where a large number of motors must be oiled. Much time can be saved under those conditions by filling a supply of extra bottles for replacement at one time on a group of motors.

Cutter Adapters for Straight- and Taper-Shank End-Mills

The cutter adapter shown in Fig. 1 for holding straight-shank end-mills in spindles or in other adapters having a cam lock and a No. 30 milling machine standard taper hole has been added to the line of the Brown & Sharpe Mfg. Co., Providence, R. I. The shank of the end-mill is held securely in the cutter adapter by means of a safety set-screw. These cutter adapters are regularly made for end-mills from 1/8 to 3/4 inch in size.

The cutter adapter shown in Fig. 2, which is intended for use with B & S cutter adapters hav-



Steelgrip Gear and Wheel Puller of a New Universal Design

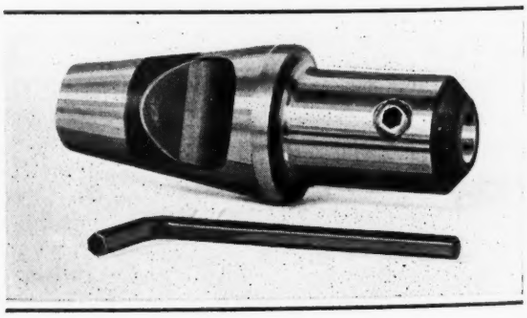


Fig. 1. Cam-lock Cutter Adapter for Straight-shank End-mills

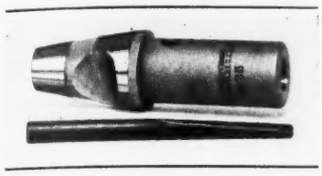


Fig. 2. Cutter Adapter for Holding Taper-shank End-mills

ing cam locks, such as described in August, 1931, MACHINERY, page 968, has also been added to this line of equipment. The adapter shown in Fig. 2 is made in two sizes to fit Nos. 5 and 7 B & S taper shanks, and is designed to provide a means for changing end-mills quickly without the necessity of removing the mill from the adapter. The end of the adapter, which fits into the adapter having the cam lock, has a No. 30 milling machine standard taper hole.

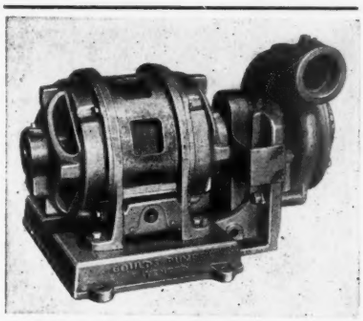
De Vilbiss Spray Painting Equipment

Rotary spray finishing machines have recently been placed on the market by the De Vilbiss Co., Toledo, Ohio, for painting small and medium sized parts. These machines are capable of production rates ranging from 1000 to 3600 pieces per hour. In addition, they are suitable for intermittent or limited production. There are two types, which are identical except that one is driven by an air motor and the other by an electric motor.

The same concern has also brought out a sixty-gallon pressure feed tank, 39 1/4 inches high by 24 inches in diameter. The walls are made of 1/8 inch thick, open-hearth steel, galvanized inside and out. A revolving agitator operates close to the bottom of the tank to prevent the accumulation of pigment. The regular equipment includes a pressure regulator and gage, safety valve, relief valve, air inlet valve, two air outlets, and two fluid outlets.

Goulds Motor-Centrifugal Pumping Unit

In a motor-driven centrifugal pumping unit which is being placed on the market by Goulds



Goulds Motor-centrifugal Pumping Unit of Close-coupled Construction

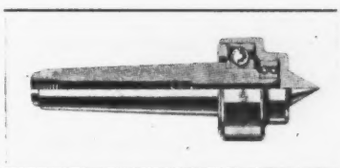
Pumps, Inc., Seneca Falls, N. Y., a close-coupled type of mounting permits the use of standard motors without special bedplates or brackets. The pump bedplate extends under the motor to relieve it of excessive strains.

This unit is built with pumps ranging in size from 3/4 inch to 4 inches having capacities up to 1000 gallons per minute. The impeller, except in the 3/4- and 1-inch sizes, is of the open-warped vane type, with passages considerably larger than in the corresponding size of enclosed impeller. The impeller hub forms a shaft sleeve over the motor shaft. An equalizing plate that is cast integral with the impeller and machined compensates for end thrust.

Sturdimatic Ball-Bearing Lathe Center

The Sturdimatic Tool Co., 5220 Third St., Detroit, Mich., has recently placed on the market a live center for lathe tailstocks having a contact member that rotates in ball bearings arranged as shown in the accompanying illustration. This center has been designed to provide uniform distribution of stresses and thus insure efficient operation.

The center is constructed to provide a cushioning action in order to compensate for expansion of the work and to protect the center itself, as well as the machine bearings. It is claimed that any tendency to spring the work out of alignment is prevented by this feature, and that the load on the machine drive unit is also greatly reduced. This center is made in nine sizes.



Ball-bearing Lathe Center Made by Sturdimatic Tool Co.

The Scrapping of Obsolete Plants

In a pamphlet entitled "Why the Scrapping of Obsolete Plants is Patriotic, Economical, Profitable," the Austin Co. of Cleveland, Ohio, analyzes in detail a specific construction job, showing what a large proportion of the cost actually is paid out as wages in one form or another. It is pointed out that no efforts under the Recovery Act can modernize an old "white elephant" plant. Wherever obsolete plants or machinery are in use, the real purpose of the Recovery Act is being nullified.

Furthermore, industrial recovery cannot be expected unless there is also a recovery of the industries that produce plants and equipment, the industries generally known as the "capital goods" industries. These normally employ 8,000,000 people and upon them the consumer goods industry must depend to a great extent for purchasing power. In 1929, the pamphlet states, $40,000,000,000 of capital (durable) goods were produced, while the total volume of consumer goods was about $30,000,000,000.

NEWS OF ASSOCIATIONS

Proposed Change of Name of Steel Treating Society

The American Metals Society will be the new name of the American Society for Steel Treating if the recent resolution of the Society's board of directors is ratified by the members.

The reasons for the suggested change are as follows: (1) The Society has long since extended its field far beyond the single aspect of steel treating; (2) members of the Society have often called the attention of the officers and directors to the fact that considerable confusion has arisen from time to time because of the implied limitations of the present name; (3) the Society's scope of activities includes non-ferrous as well as ferrous metals, with the result that any name referring to iron and steel only is misleading; and (4) the name "American Metals Society" is in harmony with the Society's purposes —to promote the arts and sciences connected with the manufacture, treatment, and uses of metals.

The required action by the Committee on Constitution and By-laws of the Society will be taken at the annual convention in Detroit early in October, after which the suggested change will be submitted to the entire membership by letter ballot. It is believed that the new name will be approved and will come into official use about January 1, 1934.

The success of the American Society for Steel Treating in the various fields of activity in which it has engaged promises still further usefulness for the Society in the broader field indicated by the new name.

The American Machine and Parts Association

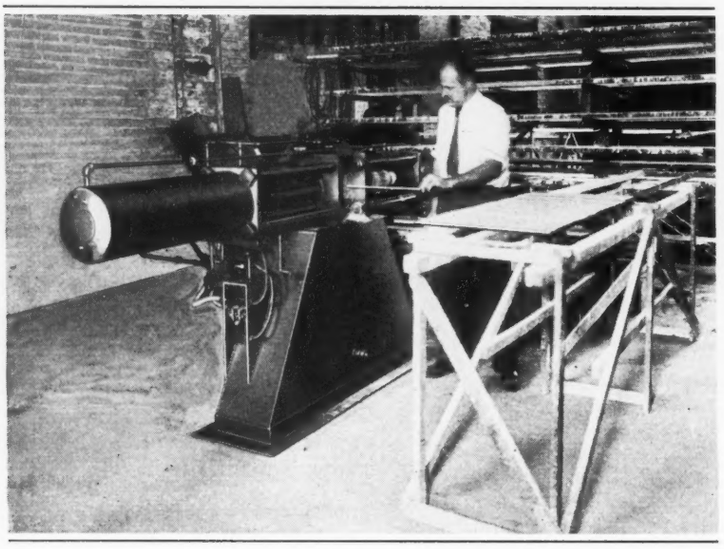
There are a number of specialty manufacturers who, feeling that they did not fit into any particular industrial classification for the purpose of solving code problems, and that they could not be classified with any already established trade association, have formed a group known as the American Machine and Parts Association. It is expected that this Association will include thousands of small factories throughout the country, for whom it will handle code and other current problems. William J. Kelly, president of Arthur J. O'Leary & Son Co., Chicago, Ill., will be the head of the new trade group, which will be affiliated with the larger Machinery and Allied Products Institute. The headquarters are at 221 N. LaSalle St., Chicago, Ill.

Power Press Builders Organize

The Mechanical Press Builders' Association has been organized by manufacturers engaged in the building of presses of various types. The Association has decided to apply for membership in the recently formed Machinery and Allied Products Institute. The officers are: President, H. U. Herrick, president of the V & O Press Co., Hudson, N. Y.; vice-president, George R. Munschauer, president of the Niagara Machine & Tool Works, Buffalo, N. Y.; treasurer, W. C. Sayle, vice-president of the Cleveland Punch & Shear Works Co., Cleveland, Ohio; and secretary, Curtis T. Ziegler, vice-president of the General Machinery Corporation, Hamilton, Ohio. Temporary headquarters will be maintained at the secretary's office, 227 Curtis Bldg., Detroit, Mich.

Non-Ferrous Foundry Association Formed

The Non-Ferrous Foundry Association recently formed is proceeding rapidly with its work of gathering statistics and organizing divisions. Among the divisions formed are the Aluminum Permanent Mold Division, the Blast Furnace Castings Division (representing copper blast-furnace castings), and the Division of Producers of Steel and Rolling-mill Bearings. Negotiations are in progress at the present time for the formation of a number of other divisions of the Non-Ferrous Foundry Association. Further information can be obtained from E. G. Fahlman, Permold Co., 6700 Grant Ave., Cleveland, Ohio.



Coating Welding Electrodes in a Machine Placed on the Market by the Electric Arc Cutting & Welding Co., Newark, N. J. Rods Automatically Fed from a Hopper Pass through the Machine and are Delivered on the Opposite Side of the Machine Completely Coated

Tool and Die Shops Form Association

The Association of Tool, Die and Machine Shops, with temporary offices at 11 New York Ave., Brooklyn, N. Y., has been formed by a large number of tool and special machinery builders in the New York metropolitan area. The Association expects to cooperate with similar associations in other parts of the country. A Code will be drafted, and the activities of the Association will aim to bring about improved conditions in the tool and die industry. Doubtless it will prove of great benefit to all the shops in this branch of the metal-working industry.

Unusual Demonstrations of Haynes Stellite

In the exhibit of the Haynes Stellite Co. at the Chicago World's Fair, some interesting corrosion tests are being carried on with Haystellite and ordinary steel. Pieces of the two metals are suspended in a bath of hydrochloric acid. This bath rapidly eats away the steel, which must be replaced every day; but the piece of Haystellite has been in the bath since the opening of the Fair and will remain there until its closing. Accurate measurements of the effect of the acid up to the present indicate that the piece of Haystellite could remain in the bath until the year 2000 without any greater amount of corrosion taking place than that suffered by ordinary steel in twelve hours.

In another display, a bar of Haynes Stellite and a bar of ordinary steel are automatically fed against a grinding wheel that runs continuously. Gages indicate that the steel wears away seven times as fast as the Stellite.

In a third demonstration, the flame of an oxy-acetylene blowpipe brings a Stellite cutting tool to a red heat while the tool is being used to cut a billet of steel. The temperature of the tool is shown by a pyrometer to be between 1200 and 1400 degrees F. The tool is in operation in this demonstration for several days before it is necessary to resharpen it.

Year's Automobile Output Greatly Exceeds 1932

The August output of the member companies of the National Automobile Chamber of Commerce (which does not include the Ford company) amounted to 171,145 units, which is more than three times the output for August, 1932. The production for the first eight months of the year amounted to 1,153,402 cars and trucks. This is 45 per cent greater than the output for the same period in 1932, and exceeds, by over 30,000 cars, the output of the entire industry for the whole of last year.

Universal Code for Determining Costs and Prices

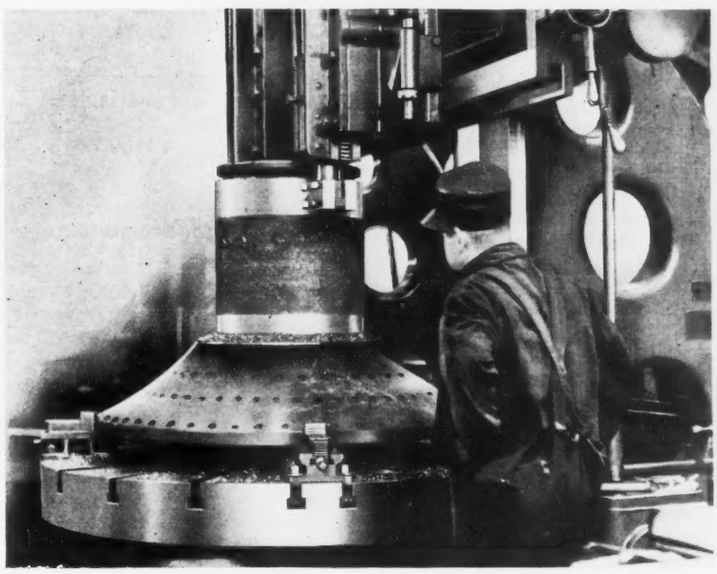
What is known as the "Denham Universal Code of Standards of Practice for Industrial Costing and Pricing," has been prepared by Robert Scudder Denham, chief engineer of the Denham Cost-finding Co., 3030 Euclid Ave., Cleveland, Ohio, and is obtainable from the author in mimeographed form at the price of $2.50 a copy. This code outlines the fundamental principles that should apply to any cost system, and is prepared in such form that it may be adopted by industrial organizations.

The author makes it clear, in a brief preface, that this code is not a "uniform cost system," since uniform cost systems are not practical, owing to the fact that there are no uniform factories. Instead, the code gives the universally applicable fundamental principles upon which cost systems must be constructed.

The code covers broadly the following subjects: Costing plan characteristics; fundamental principles; sound economic practices; the procedure of establishing a costing plan; the classification of expenses; basis of expense distribution; the analysis of costs; industrial pricing for profits; and wrong and right methods of calculating selling prices. Mr. Denham first applied his principles of cost engineering in the printing industry in 1908, and has since directed the installation of cost-finding systems in more than 1200 industrial plants.

Factors that Affect Accuracy of Surface Broaching

The accuracy that can be obtained in surface or external broaching, according to a statement made by C. E. Bleicher, Chrysler Corporation, in a paper before the International Automotive Engineering Congress recently held in Chicago, is governed by two conditions—first the design of the part to be broached and second, the broach length. The part should be heavy enough to withstand the cutting pressures necessary in surface broaching, and it should be of such shape that it can be firmly supported and securely fastened in a fixture. Other things being equal, the longer the broach, that is, the more cutting teeth available, the greater is the accuracy obtainable and the better the finish.



Machining a Trunnion for a Ball Mill at the Plant of the Anaconda Copper Mining Co. The Worn Trunnion has been Built up to a Diameter of 21 Inches by the Deposition of 300 Pounds of Electrode With a General Electric Automatic Arc Welding Head. Total Cost of Reconditioning was about $75

It was also pointed out that surface broaching owes its success to the solid manner in which the broach and work can be supported. The broach is backed up its full length, while the work-holding fixture can also be well supported.

Engine Frame of Welded Construction

The engine frame for the 600-horsepower Winton engine which will provide power for the new streamlined, aluminum-body passenger train of the Union Pacific Railroad, will be manufactured in arc-welded rolled steel construction by the Lukenweld, Inc., Division of the Lukens Steel Co., Coatesville, Pa. In addition to the engine frame proper, the oil pan and the twelve cylinder heads will be of welded construction. The engine frame will be constructed from high-strength alloy steel, and after completion, will be subjected to radium inspection to insure the quality of the welds.

NEWS OF THE INDUSTRY

Illinois and Indiana

VASCOLOY-RAMET CORPORATION, North Chicago, Ill., has been organized for the manufacture of all grades of tantalum carbide and the production of all kinds of tantalum-carbide cutting tools, dies, wearing surfaces, and similar products. In this company are consolidated the tantalum-carbide manufacturing divisions of the VANADIUM-ALLOYS STEEL CO., the FANSTEEL PRODUCTS CO., INC., and the RAMET CORPORATION OF AMERICA. The products of the Vascoloy-Ramet Corporation will be offered under the trade name "Vascoloy-Ramet" through the Vanadium-Alloys Steel Co.'s sales department, Pittsburgh, Pa., and its duly appointed sales agencies, including the sales agencies of the Ramet Corporation of America.

ZAPON-BREVOLITE LACQUER CO., North Chicago, Ill., has been formed by the combination of the BREVOLITE LACQUER CO. and the western division of the ZAPON CO., the oldest manufacturer of pyroxylin base finishing materials. The new combination will continue to manufacture lacquers and finishing materials, many of which are used in the machinery industries.

R. J. CROSSETT has been appointed sales representative of the NATIONAL AUTOMATIC TOOL CO., Richmond, Ind., in the Chicago district. Mr. Crossett will be associated with DAVE L. RILEY, manager of the Chicago sales office, at 1908 Engineering Bldg., Chicago.

D. V. CHANCELLOR has been appointed manufacturer's representative by the EX-CELL-O AIRCRAFT & TOOL CORPORATION, Detroit, Mich., for southern Indiana and the surrounding territory, with headquarters at 1010 Bellemeade Ave., Evansville, Ind. He will handle all the products of the company, including those of the Continental Tool Works Division and the Krueger-Wayne Tool Co. Division.

Massachusetts

GEORGE H. CORLISS has been appointed sales promotion and advertising manager of the Lewis-Shepard Co., Boston, Mass., manufacturer of material-handling equipment. Mr. Corliss was previously associated with the J. A. Fay & Egan Co., Cincinnati, Ohio, and the Kewaunee Mfg. Co., Kewaunee, Wis. Before going west, he was connected with the S. A. Woods Machine Co. of Boston. Mr. Corliss has had a wide experience in marketing and has written many articles on marketing, merchandising, sales promotion, and advertising.

F. F. BRAND has been appointed assistant to the manager of the Pittsfield Works of the General Electric Co., in charge of engineering. I. H. SCLATER has been appointed engineer of the power transformer engineering department. LEROY S. SCHELL has been appointed assistant engineer in charge of the design of power transformers.

LEO I. SMITH, 45 Gorham Road, Belmont, Mass., has been appointed district representative for the New England territory of Roots-Connersville-Wilbraham, Connersville, Ind., manufacturers of blowers, gas exhausters and meters, liquid and vacuum pumps, inert gas machines, etc.

Michigan and Wisconsin

WALTER F. CAHILL has been appointed sales representative in the Detroit district for the NATIONAL AUTOMATIC TOOL CO., Richmond, Ind. Mr. Cahill will be associated with ED. A. HARPER, manager of the Detroit sales office, which is located at 409 New Center Bldg., Detroit. He was previously connected with the Krueger-Wayne Division of the Ex-Cell-O Aircraft & Tool Corporation, at Detroit.

DETROIT ALLOY STEEL CO., Detroit, Mich., announces that, because of the similarity of the trade name "Dascoloy" and the name of another trademarked alloy, the company has decided to change the name of the alloy heretofore known as Dascoloy to "Krokoloy." Hereafter, the company's leading chrome-cobalt-alloy tool steel, cast to shape, will be known by the latter name.

DEVLIEG MILLING MACHINE CO., Jackson, Mich., has been incorporated to take over and continue the business of the former DEVLIEG MACHINE TOOL CO., which has been dissolved. The new company will manufacture a full line of milling machines and auxiliaries.

W. G. NICHOL, 410 Mariner Tower, Milwaukee, Wis., has been appointed exclusive sales representative for Wisconsin of the R. G. HASKINS CO., 4636 W. Fulton St., Chicago, Ill. He will handle the company's line of flexible-shaft, screwdriving, and tapping equipment.

In his engineering consulting capacity with the Harnischfeger Corporation of Milwaukee, Wis., KLAUS L. HANSEN flies from city to city in maintaining his schedule of welding promotion. Mr. Hansen is carrying on plant educational work with his newly developed arc torch which is designed for brazing non-ferrous metals. This new torch can be operated from a standard arc-welder generator.

New York

WILLIAM L. BATT, president of the S K F Industries, Inc., New York, has been elected a vice-president of the American Society of Mechanical Engineers. Mr. Batt has been a member of the Society since 1911 and has been actively interested in its work, serving as chairman of the Revenue Committee, the Committee on Meetings and Programs, and the Coordination Committee of Engineering Societies. Previous to being elected vice-president, he served as a manager of the Society. He has also been actively interested in the work of the Society of Automotive Engineers.

E. A. MAIN, formerly with the E. W. Bliss Co., Brooklyn, N. Y., has been made district sales manager for the Metropolitan New York district of the Ferracute Machine Co., Bridgeton, N. J., manufacturer of presses and dies. Mr. Main was connected with the E. W. Bliss Co. for twenty-five years in sales and engineering work, and for the last thirteen years served as export manager. In his new capacity he will act as direct representative for the Ferracute Machine Co. and can be reached at either 75 Eighty-eighth St., Brooklyn, N. Y., or Room 1532, 55 W. 42nd St., New York City.

E. L. THEARLE, since 1928 with the mechanical research section of the General Electric Research Laboratory, has been placed in charge of the activities of the mechanical section, succeeding A. L. KIMBALL, who has been transferred to the engineering general department and who will assist all design engineering departments of the company on problems involving ventilation, vibration, and noise.

PACKAGING MACHINERY MANUFACTURERS' INSTITUTE, INC., was organized at a meeting in Buffalo, August 21, at which about 75 per cent of the industry was represented. H. H. Leonard, vice-president and general manager of the Consolidated Packaging Machinery Corporation, Buffalo, N. Y., is president; W. J. Donald, 52 Wall St., New York City, is executive vice-president and treasurer.

GEORGE B. KARELITZ has resigned as manager of the Marine Engineering Division of the Westinghouse Electric & Mfg. Co., South Philadelphia Works, to become professor of mechanical engineering at Columbia University. Mr. Karelitz intends also to engage in consulting engineering practice.

MORTON MFG. CO., Muskegon Heights, Mich., has appointed R. LEWIS GIEBEL, 1501 Undercliff Ave., Bronx, New York City, representative in the New York metropolitan area of the line of machine tools and finished machine keys made by the company.